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Technical Report D-77-24

6 AQUATIC DISPOSAL FIELD INVESTIGATIONS, DUWAMISH WATERWAY DISPOSAL SITE, PUGET SOUND, WASHINGTON

APPENDIX F: RECOLONIZATION OF BENTHIC MACROFAUNA OVER A DEEP-WATER DISPOSAL SITE

by

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AQUATIC DISPOSAL FIELD INVESTIGATIONS
DUWAMISH WATERWAY DISPOSAL SITE
PUGET SOUND, WASHINGTON

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Seasonal monitoring of benthic macrofauna and fish stomach contents was conducted over a deep (64 m) experimental disposal site in the Duwamish River-influenced portion of Elliott Bay, Puget Sound, Washington. Triplicate samples were collected during a 9-month sampling period within the disposal site and at four reference stations, two from the greater (east side) and two from the lesser (west side) river-influenced portions of the bay.

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20. ABSTRACT (Continued).

The areal extent of the disposed dredged material was discernible from the changes in sediment composition was well as changes in biomass density and species composition of the benthic community. During the 9-month postdisposal sampling period recovery was not complete. Three recolonizing phases were recognized in the succession of the benthic fauna. Phase I was characterized by the immediate recolonization by fish and shrimp, migration of predisposal occupants to the surface of the deposit, and migration of species into the disposal area from adjacent habitats. Phase II was represented by a summer recruitment period of opportunistic species and annuals onto the disposal site, and Phase III was distinguished by an increase in predatory worms and subsequent decline in opportunistic species. The last phase of the succession was not observed. Recovery of many of the nonbenefited annuals and climax species was not observed during the 9-month sampling period.

Seasonal changes in the dominant food items in the stomachs of flatfish were indicated. Low numbers of small crustaceans occurred during the winter followed by a spring and summer increase in food items consisting mainly of large clams and motile polychaetes. A change in diet resulting from the disposal activity was observed in flatfish with a high occurrence in stomach contents of opportunistic worms over the disposal site.

SUMMARY

This study was conducted for the Dredged Material Research Program (DMRP) of the U.S. Army Engineers Experiment Station (WES) as part of their Environmental Impacts and Criteria Development Project (EICDP). The objectives of this study were:

a. Determine the effects of dredged material disposal on the benthic macrofauna recolonization in terms of species composition, biomass, and density.

b. Assess the rate at which recoloniztion took place as well as document possible succession occuring over the disposal site.

c. Evaluate the information based on a literature review of benthic community disposal studies, analysis of stomach contents of fish, previous studies on the benthic community, and life histories of the species found over the disposal areas.

Triplicate Van Veen bottom grab samples were collected from 20 stations, once before disposal and again 10 days, 1 month, 3 months, 6 months, and 9 months after disposal. Over the disposal site a 4 by 4 station grid, 1200 by 1200-ft. in dimension with stations 300 ft. apart was established. Four reference stations were sampled in triplicate, two each located in the eastern and western portions of Elliott Bay. Prior to disposal 20 single sample stations were collected within the dredge channel of the Duwamish River. In order to provide demersal fish for stomach analysis of their benthic macrofauna contents, otter trawls were conducted by the National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA).

The sediment composition was altered by the disposal activity over the entire experimental grid area causing an increase in wood and other plant debris materials. After disposal the reduction in the densities, number of species, and biomass occurred throughout most of the grid stations at the disposal site. Reference stations were not influenced by the disposal activity. At the margin and corners of the disposal grid system many clams and worms were able to resurface through the thin surface deposit of dredged material. Over the direct impact site complete burial took place. Recruitment during the summer months was the major mechanism in the recolonization of the disposal sites. However, some benthic forms may have helped recolonize the disposal site through

horizontal migration from marginal stations. Three phases were recognized in the succession that took place during the 9-month study. Phase I was represented by the resurfacing and migration of predisposal macrofaunal occupants and the immediate recolonization of the disposal site by fish and shrimp; Phase II was a summer recruitment period for opportunistic polychaetes and an increase of annuals; and Phase III was characterized by an increase in predatory worms and benefited annuals. After nine months community structure had not yet returned to its predisposal composition. Pelecypods appeared to be showing a progressive decline over the disposal impact area with subsequent replacement by the opportunistic and benefited annuals.

Flatfish showed seasonal changes in stomach contents. During winter months near empty stomachs contained food items consisting mostly of small crustaceans where during spring and summer months flatfish fed selectively on relatively larger clams and motile, predatory, and opportunistic polychaete worms, despite the abundance of the tube-dwelling polychaetes and small clams.

Several conclusions reached in this study have implications on disposal site selection criteria. The results of this study as well as a review of other disposal studies indicate slower recovery rates at disposal sites that occur in either deep or protected habitats. The addition of wood debris to bottom substrates in general has a deleterious impact on the recolonization of benthic infauna. Deep water disposal should occur only during the season when macrofaunal densities are low (winter) or before they begin seasonal recruitment (summer). In addition to substrate, depth and degree of protection from water turbulence, consideration should be given to the relative influence of time, predation biological accomodation, production, spatial heterogenity and to the effect environmental stability may have on community resilience to disposal activity. These factors should be considered during predisposal pilot studies, which should make an effort to predict sources of opportunistic species, annuals, and climax speices. Pilot studies should be conducted after recruitment of benthic fauna has occurred (late summer fall) in order to best assess regional trends in macrofauna.

DISCLAIMER

PREFACE

This report describes the work performed by Shoreline Community College for the Environmental Laboratory (EL) of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, under Interagency Agreement WESRS 76-90 dated 23 December 1976 and entitled "Duwamish Waterway Aquatic Disposal Field Investigation, Elliott Bay, Puget Sound, Washington, Phase I-IV." The work was performed as part of EL Work Unit 1A10B, of the Office, Chief of Engineers' Dredged Material Research Program (DMRP). Results of the Phase I Pilot Study on the distribution of benthic macrofauna in the southern portion of Elliott Bay were also included in the work in order to document the macrofauna criteria used in the ultimate selection of the experimental disposal site. The report also incorporates figures from an earlier regional baseline study conducted for the Seattle District in 1974 concerning the distribution of the microbiogenic sediment components and macrofauna of Elliott Bay.

Principal investigators were Robert A. Harman and John C. Serwold. This project was made possible through the combined efforts of the following marine technicians at Shoreline Community College who participated in both field collection and laboratory preparation of the data: Paul Farley who oversaw the field collection of the data and was instrumental in the construction of the grab sampler, water pump unit and multiple corers utilized in the study and Larry Ruby and Lonnie Johnson who helped in collection of samples and guided the data preparation and drafting of figures. The latter portion of the field and laboratory efforts were directed by Richard Heggan who also helped identify worm tubes and molluscs. The majority of molluscans were identified by Cindy Kingry and Deelora Riff. Completion of the computer and manuscript tables was accomplished by Glen Greathouse, Robert Martinez, Susan Larsen and Mary Scott. Greatly appreciated were the efforts by Bonnie Glantz for typing the manuscript and tables.

Shoreline Community College was subcontracted through National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA). Early negotiation and contract assistance was provided by George Snyder, NOAA. Collection of samples was done on board the National Marine Fisheries Service vessel H.S. STREETER under the command of

Richard Hughes. During Phase I of the study contract manager for WES was Jim Reese. Throughout the majority of the study Jeffrey Johnson, EL, managed the project and provided valuable assistance by making existing data and current literature available. Appreciation is also expressed to Rex Bingham, EL, for reviewing the report and providing graphs plotted from raw data. Appreciation is also expressed to Dr. Richard Peddicord, Dr. Joseph Carroll, and Dr. Henry Tatem who critically reviewed the manuscript and Jamie Leach who edited the manuscript. The study was under the general supervision of Dr. Robert M. Engler, EICDP manager, and under the general supervision of Dr. John Harrison, Chief, EL. Directors of WES during the conduct of the study were COL G. H. Hilt, CE, and COL J. L. Cannon, CE. Technical Director was Mr. F. R. Brown.

Greatly appreciated were the use of the unpublished reports: Polychaete Keys, by Dr. Karl Banse and Dr. Katherine Hobson; A Review of Polychaete Feeding Modes, by Dr. Kristian Fauchald and Dr. Peter A Jumars; and A Description of Puget Sound's Circulation and Water Properties, by Dr. Clifford Barnes and Dr. Curtis Ebbesmeyer.

CONTENTS

CONTENTS

LIST OF FIGURES

LIST OF FIGURES

LIST OF FIGURES

LIST OF TABLES

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI)

UNITS OF MEASUREMENT

Multiply	By	To Obtain
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
miles (U. S. nautical)	1852.0	metres
fathoms	1.8288	metres
square feet	0.9290304	square metres
acres	4046.856	square metres
cubic yard	0.7645549	cubic metres
cubic feet per second	0.02831685	cubic metres per second
tons (short)	907.1847	kilograms
Fahrenheit degrees	0.555	Celsius degrees or Kelvins*

*To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

AQUATIC DISPOSAL FIELD INVESTIGATIONS, DUWAMISH WATERWAY DISPOSAL SITE, PUGET SOUND, WASHINGTON

APPENDIX F: RECOLONIZATION OF BENTHIC MACROFAUNA OVER A DEEP-WATER DISPOSAL SITE

PART I: INTRODUCTION

1. The larger cities of western Washington, Seattle, Everett, Tacoma and Bellingham are located adjacent to major rivers that flow into the glacially shapened fjords of Puget Sound (Figure 1). Each of these cities contains port facilities and industrial complexes which, because of river sedimentation, require periodic dredging. The dredged debris is typical of river-influenced estuaries containing stagnant hydrogen sulfide rich (H_2S) sediment as well as unnatural additions from cities and port and industrial activity.

2. This study is part of a comprehensive Dredged Material Research Program (DMRP) conducted by the U.S. Army Engineer Waterways Experiment Station (WES) and attempts to determine the effects of open-water disposal on water quality and aquatic organisms through field and laboratory investigations as part of the DMRP Environmental Impact and Criteria Development Project (EICDP). The Duwamish River Disposal Site at Elliott Bay is one of five ongoing nationwide aquatic field investigations, the other being located on Lake Erie off Ashtabula, Ohio, on the mouth of the Columbia River, Washington, and in the Gulf of Mexico off Galveston, Texas; and off Eatons Neck in Long Island Sound, New York.

3. This study area has added significance because it is the deepest water experimental disposal site studied to date by the DMRP and since the dredged material is considered potentially polluted as a consequence of an accidental spill of polychlorinated biphenyls (PCB's) into the Duwamish River in September 1974. The study consisted of five phases: Phase I, a pilot study in southern Elliott Bay in order to select the experimental disposal and reference sites; Phase II, predisposal sampling at reference disposal and river dredging sites (Figure 2); Phase III, dredging and disposal of 114,250 m^3 of Duwamish River channel sediment; Phase IV, postdisposal sampling of reference and disposal sites to monitor the benthic macrofauna recovery; and Phase V, analysis and report preparation. Concurrent investigations involved Elliott Bay

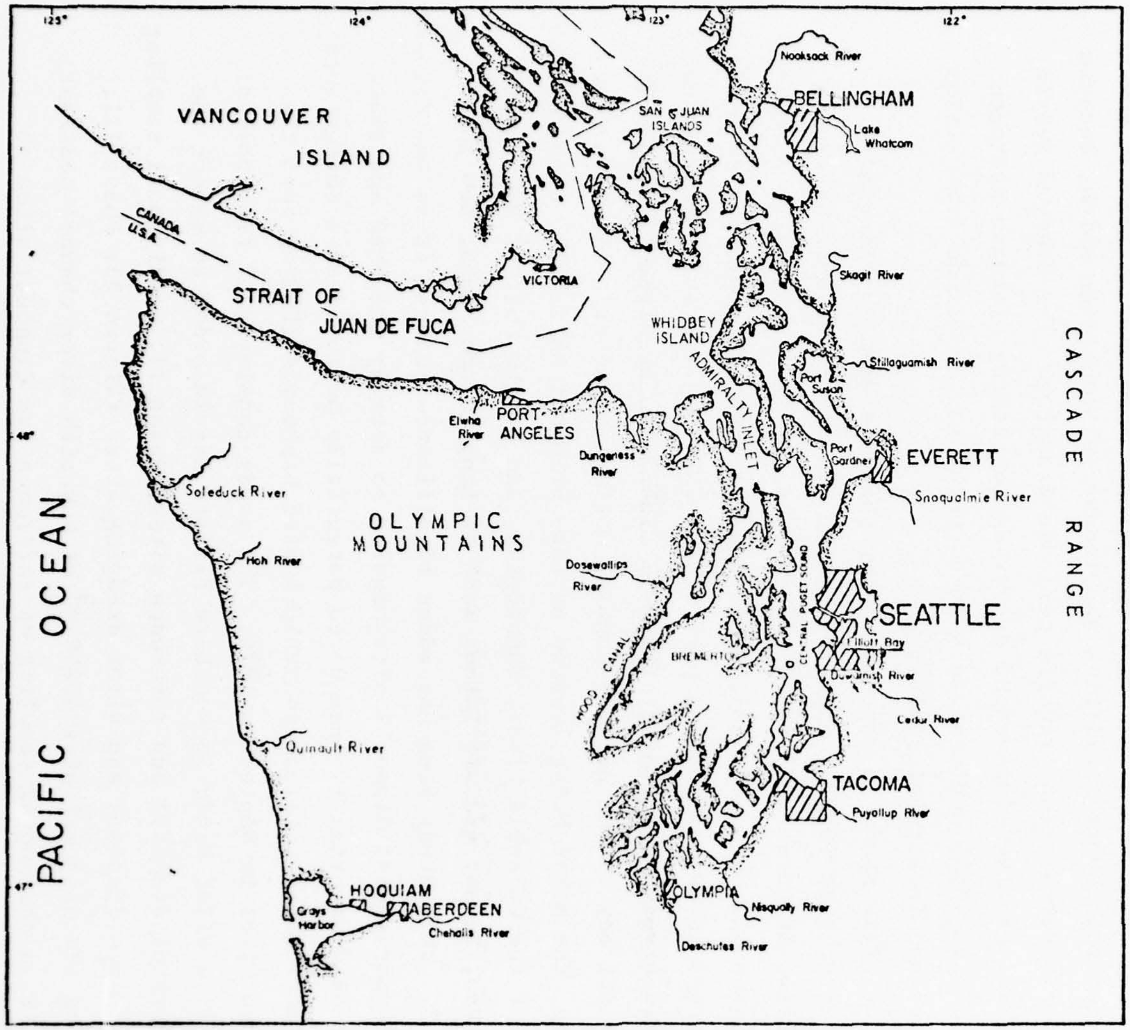


Figure 1. Location map

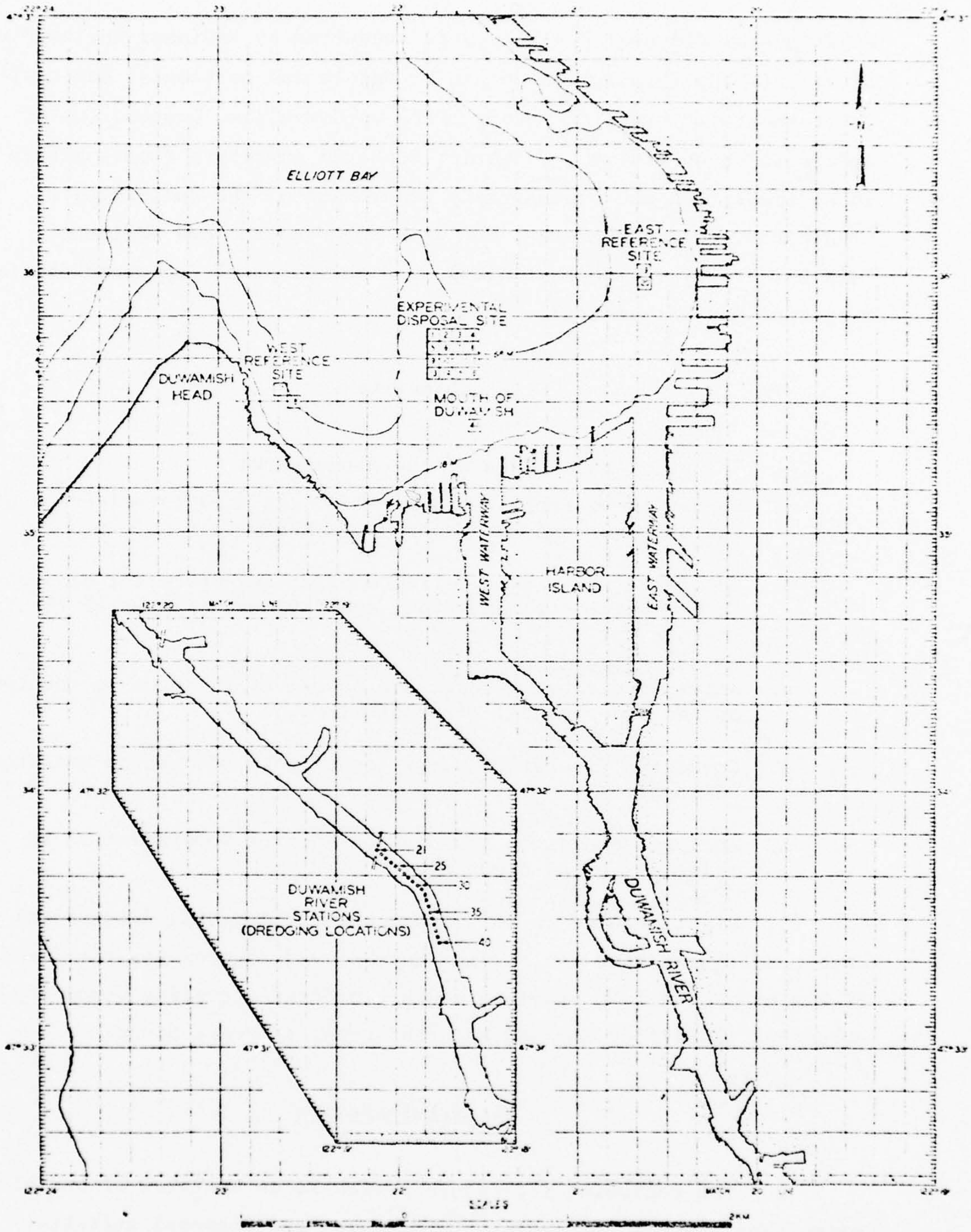


Figure 2. Locations of dredging, disposal, and reference (control) sites. Dredging was accomplished in the vicinity of the river stations shown in the insert.

experimental disposal projects were conducted by National Marine Fisheries Service (NMFS) (Biological uptake of metals and toxicants, demersal fish), Environmental Protection Agency (EPA) at Corvallis, Oregon, (water and sediment chemistry), Fisheries Research Institute (heavy metals in sediment) and the Oceanography Department of the University of Washington, (oil and grease, PCB's in Water Column and Sediment), Yale University (current studies), and the Corps of Engineers (sediment dispersal and bathymetry).

Objectives

4. The major objectives of the study were;

a. Survey the macrofauna to provide data used in selection of the disposal and reference sites (Phase I).

b. Determine the spatial effects of dredged material disposal on the species composition, density, and biomass of the macrofauna.

c. Assess the rate, extent, and nature of the benthic recolonization of the experimental disposal site.

d. Conduct a literature survey on effects of dredged material disposal.

e. Analyze changes in stomach contents of demersal fish in relation to the dredging.

5. Also included in this study are the regional discussions of data and figures based on earlier unpublished reports for the Corps of Engineers and from previous benthic studies Shoreline Community College conducted in Elliott Bay and adjacent areas of Puget Sound.

Literature Review

6. The following literature review is an overview of benthic macrofauna studies that relate to dredging and disposal activity. Puget Sound disposal studies are described as well as others from the west and east coast. A brief review of other sea bottom disturbance

studies (eg. sewage and pulp mill waste disposal, oil spills) are reviewed to document similarities in sea bottom recovery of the benthic macrofauna as compared to disposal disruptions of benthic communities. The factors that are regarded in the literature important to community resilience to stress conditions are also discussed. A summary of other Puget Sound macrofaunal studies is included.

General

7. The volume of sediment dredging to maintain navigational channels, ports and marine facilities throughout the United States is estimated to be 300 to 400 million cu yd* (Lee 1976, Engler 1977). Aquatic dredge disposal sites will increase as land disposal sites are filled and there is increased use of coastal land (Rousefell 1972, Watling 1975). In the study area during the last 27 years 4,287,300 cubic yards of dredge materials from the Duwamish River Channel have been disposed of by pipeline to landfill areas while more recently 775,327 cubic yards were disposed in offshore marine waters.** Increasing demands for aquatic disposal sites will occur as land areas are filled and utilized for industrial sites. In both Seattle and Tacoma industrialization and port facility expansion have almost completely utilized the tideflats and salt marshes of their respective river deltas. Because of the undesirable loss of tideflats landfill sites must now seek other more distant landfill or marine disposal sites. Because of the growing pressure to use aquatic disposal sites, a concerted effort is presently being made by the Corps of Engineers to evaluate the impact of dredged materials disposal on aquatic environments and to improve dredging and disposal practices (Boyd et al. 1972). Results of the ongoing projects of the DMRP with emphasis on the EICDP are reviewed by Engler (1977).

Puget Sound disposal studies

8. The most comprehensive disposal site study in Puget Sound was summarized by Westley et al. 1975. This recolonization study was conducted in protected embayments (Budd Inlet, Olympia Harbor) and water turbulent tidal channels (Dana Passage) near Olympia. No effects were observed on the phytoplankton nor was there any uptake of toxic

*A table of factors for converting U.S. customary units of measurement to metric (SI) units can be found on page

**Personal communication, June 1977, Robert Parker, Chief of Channel and Harbor Section, Operational Division, CE, Seattle, WA

substances by salmon or oyster and clam larvae observed. Diver observations of macroscopic organisms indicated no effect in Olympia Harbor. An initial decrease in abundance and diversity following disposal was observed in Budd Inlet. Although an initial burial of up to 3 ft. occurred in Dana Passage rapid recovery of geoducks was observed 5 months after the disposal impact. Observations indicate the disposed dredged material fell in descrete clumps, which were eroded when bottom current velocity exceeded 27 cps.

9. A study on effects of pipeline disposal on the larger macrofaunal organisms was conducted by Goodwin (1973) on the upper portion of the Skagit River Delta and within the Swinomish Channel. Macroscopic organisms were collected using a diver-operated venturi dredge where benthic organisms were collected in a 1/4-in. mesh screen basket. The disposal of 13,900 cu yd of dredged material did not appear to affect either substrate composition or benthic species diversity or abundances in the disposal areas. No succession was observed during the apparent rapid recolonization of the disposal site.

10. Other studies in Puget Sound consist of postdisposal analysis of the benthic macrofauna. In some cases these studies are complicated by factors other than disposal impact. Off Fourmile Rock decreases in the benthic polychaete worms, clams, and pectinarian worm tubes were noted over a deep-water (150 m) disposal site despite the absence of recorded disposal activity for at least 20 years (Harman et al. 1974a). The relative severity of disposal impact on macrofauna in Shilshole Bay near Elliott Bay was difficult to ascertain from the data because of added influences of sewage sludge deposits and river influenced sea bottoms (Harman et al 1977a). Similar problems in the assessment of dredged material impact relative to other influences, occurred in Bellingham Bay and Everett Harbor where the benthic fauna showed marked reductions in densities, biomass and number of species over dredge and sludge deposits from both disposal and pulp mill activities (Anonymous 1967, Malkoff 1976, Kisker 1976, Harman et al. 1977b). These sites were predominately recolonized by opportunistic polychaete worms.

West coast disposal studies

11. A rapid recovery of both macrofauna and megafauna occurred over the experimental disposal site off the Columbia River in Washington and Oregon (Richardson et al. 1977). Eveness and diversity returned to predisposal values eight months after disposal and densities returned within 10 months. Rapid recovery or recolonization was attributed to thick shelled gastropods, Olivella sp., and pelecypods, Siliqua petula, being able to burrow through the disposal overburden as well as rapid migration into the disposal area by small mobile crustaceans. No evidence of transport of species from the dredging site was observed. Disposal influence was principally caused by burial and sediment texture changes. Turbidity, the presence of pollutants, and high amounts of organic matter were not considered to be factors inhibiting the recolonization. Unlike other disposal studies, diversities increased immediately after disposal primarily caused by the disproportionate reduction in the abundant polychaete Spionophanes bombyx. Species associated with the Columbia River were less affected by disposal activity than tube dwellers and deposit feeders more typical of the offshore communities.

12. Oliver et al. 1976 described the succession and recovery rates in harbors, shallow wave-influenced habitats, and relatively deep (30 m) offshore near submarine canyon habitats in Monterey Bay, California. Recovery rates were influenced by the degree of natural seafloor disturbances and seasonal recruitment activity. In shallow habitats influenced by wave activity, recovery was rapid and recolonization was accomplished by motile organisms such as fish, starfish, and amphipods. In contrast, the protected habitats in the harbor and near the submarine canyon were slower to recover. Two succession phases were observed. First to recolonize these protected sites (where opportunistic polychaetes were abundantly found in sediment traps) were Armandia brevis a sedentarian morphologically similar to the opportunistic species found in this study, Ammotrypane aulogaster. The second phase was characterized by recolonization by dominants from adjacent habitats. Oliver et al. 1976 found that bivalves recovered as a slower rate than polychaetes and crustaceans. Recovery rates were also observed to be lessened by the

presence of tube dwelling phoronid worms.

13. Investigations of dredging and disposal effects on the benthos in shallow (less than 15 m) portions of Coos Bay, Oregon, indicated rapid recovery to predredge and predisposal sea bottom conditions (Slotta et al. 1973, Slotta et al. 1974). Rapid recovery was attributed to the presence of faunas consisting primarily of opportunistic species. In contrast with Oliver et al. 1976 and this study bivalve recovery was greater than other macrofaunal components (Slotta et al. 1973).

14. In San Francisco Bay and San Pablo Bay, California naturally stable bottoms showed a greater reduction in fish and benthic macrofauna densities, number of species, and biomass following dredging and disposal than naturally less stable habitats or areas having marked salinity changes (Anonymous 1970). In the stable habitat, recovery was not complete after 2 years. No apparent damages occurred to fisheries resources in the less stable habitat.

15. The response of benthic communities to stress caused by sewer outfalls, oil refineries, and marinas has been studied off Southern California. Gregg and Kiwals 1970 and Stephenson et al. 1975 described the reduction of species diversity and densities associated with sewer outfalls. Many of these opportunistic species are also found in the Duwamish River channel. Reish (1961) found no indication of succession following dredging in a boat harbor in southern California. In Anaheim Bay, California, Reish and Kauwling, 1971 found that the average number of species was slightly higher over a dredged area but had lower concentrations compared to the undredged portion of the harbor. Changes in polychaete densities have also been described by Reisch 1965 in Los Angeles Harbor that appeared to be influenced by oil refinery wastes. Polychaete worms as indicators of stress or low oxygen environments are described by Reish 1960, 1966, 1972.

16. Ongoing investigations in British Columbia are related to deep-water disposal studies off the Frazier River, recolonization studies of estuaries influenced by pulp mills, as well as laboratory studies related to stubstrate preference by benthic organisms (Brinkhurst

et al. 1976). Important to this study were the results of Chang and Levings 1976 whose laboratory studies indicated avoidance by most organisms of wood and fiber substrates.

East and Gulf Coast studies

17. Most studies on the East Coast relating to dredging and the impact of dredged material disposal on marine organisms were conducted in shallow habitats typical of nearshore marine environments of the eastern United States. In most cases, a decrease in the number of species, densities and biomass occurred after dredging or disposal with subsequent rapid recoveries.

18. In the upper Chesapeake Bay, Pfitzenmeyer 1970 found that species diversity and biomass recovered 1 year after dredging, but dredged channels showed erratic temporal fluctuations in benthic densities and an overall decline in species diversities. Flemer et al. 1968 indicated that no acute effects were observed on zooplankton, phytoplankton, fish eggs and larvae except for the benthos. Similar results were found by Cronin 1970, who described a 70 percent reduction in benthos density, a 67 percent decline in biomass and a reduction in species richness in the Chesapeake Bay area. However, no effects were recognizable after 1.5 years in areas having similar substrates as to the disposed dredged material. In lower Chesapeake Bay, Harrison et al. 1964 found similar reductions but rapid recolonization occurred enhanced initially by active motile organisms and dispersed larvae caused by the well-mixed waters.

19. The succession of large magafaunal animals, peracarid crustaceans, and opportunistic polychaetes that recolonized the dredged material in Rhode Island Sound were described by Saila, Pratt and Polgar 1972. Significant were the reductions in the tübe-building communities and absence of offshore occupants recolonizing the disposal site. No effects of turbidity were observed on crabs and lobsters. Few benthic species were able to resurface through the thick disposal mounds. Amphipods and several small polychaetes were recognized as better adapted

to recolonize new sea bottoms. Species transported from the dredged site were recognized over the disposal site.

20. A decrease in species richness and density occurred after disposal in the mouth of the Delaware River, but a rapid recovery occurred between the winter and summer months (Maurer et al. 1974). Similar results were found in shallow habitats adjacent to a breakwater by Leathem et al. 1973. Reduction in normal occupants and slight increases in other species as well as an introduction of new species were observed to occupy this site after 11 months. A decrease in fish biomass in dredged channels in New Jersey is reported by Murawski 1969.

21. In a shallow habitat in Long Island Sound (less than 3.5 m) motile errantian polychaete worms and crabs were the first to occupy a dredged channel, Kaplan et al. 1974. Permanent decreases in the capitellid polychaetes slight increases in some clams, and an introduction of new species occurred. Most of the dominant and subdominant species had not recovered 11 months after dredging. Decreases in the macrofauna biomass in dredged channels of Mouches Bay, New York, are reported by O'Connor 1972.

22. In a New York bight dredged material and sewage sludge deposits have had a toxic effect on benthic organisms resulting in a near dead area recolonized mainly by opportunistic worm species and foraminifera (Anonymous, 1972, Gross et al. 1971, Pearce, 1971, Pearce et al. 1975). Pratt, et al 1973 discussed the tolerant species or opportunistic species occuring in solid waste disposal sites in deep habitats 80 m to 4000 m deep off the New England Coast. Many of these species are found in Elliott Bay.

23. Decrease in the benthic macrofauna of the shallow habitat of Tampa Bay, Florida due to dredging are described by Taylor and Saloman 1968. They reported an 80 percent decrease in numbers of species, mostly fish over a dredged portion of the bay. In 10 years the area had not recovered caused in part by its poor circulation. Hellier and Kornacker 1962 described the rapid recovery of the marine fauna in dredged channels of Galveston Bay.

24. MacKay et al. 1972 describes a deep water (100 m) sewer and

dredged material disposal site as polychaete rich in the Clyde Estuary, England. Beyer 1968 documents the effects on fish and fisheries in a Oslofjord influenced by waste disposal where reduction in the fauna occurs and indicator species are present. The recolonization or the adjustment of macrofauna to the cessation of pulp mill water pollutants in a Swedish fjord is described by Rosenberg, 1972. Many species reported are similar to the fauna of Elliott Bay. Grassle and Grassle, 1974 discuss and define opportunistic species based on their observation of succession after an oil spill in Buzzard Bay, Massachusetts. McCall, 1977, describes the recolonization of benthic macrofauna over experimental defaunated substrates in Long Island Sound. Three groups of recolonizers were recognized, one characterized by opportunistic species another by equilibrium species (climax species of this study) and a intermediate group with characteristics having intermediate peak abundances and death rates that are constant in space and time. Dauer and Simon 1976 describes the recovery of an intertidal habitat after defaunation by a red tide. Succession was characterized by opportunistic polychaetes and motile migrants.

Factors influencing disposal impact and recolonization

25. As discussed above most studies indicate short term decreases in the benthic macrofauna, number of species, density, and biomass while pelagic organisms such as phytoplankton, zooplankton, and fish eggs appear to be unaffected. The decline in the benthos has been attributed primarily to burial and suffocation due to disposal with lesser influence or inconclusive influence by turbidity, anoxia, hydrocarbons, heavy metals or changes in the substrate (O'Neal et al. 1971, Saila, et al. 1971, Keck, et al. 1976).

26. An excellent literature review on the effects of suspended solids on marine organisms and results of experimental turbidity studies on organism is given by Peddicord et al. 1976. The laboratory effects of suspended sediment on fish, include clogging of gills, tissue abrasion and enhanced predation (Bacescu, 1972, Sherk et al. 1974). Suspended sediment effects on peleycypods are abnormal larvae development

in clams, clogged gills, physical impact on eggs and larvae, blocked digestive tracts, decreased growth rates, and lessened pumping rates of pelecypods, Loosanoff, 1961. However, suspended sediment conditions of the laboratory studies exceeded observed disposal values as the turbidity cloud neither has high concentrations nor persists over disposal sites for significant lengths of time (Engler, 1977). However, it has been postulated that sea bottoms with high suspended sediment contents or those having "false sea bottoms" (fluid muds) may contribute to the community structure changes of suspension feeding organisms Rhodes 1973. Organisms adapted to turbidity habitats may not be harmed as well as burrowing bivalves and polychaetes (Slotta and Williamson, 1974).

27. In dredged material disposal and sludge deposits with high organic matter and wood debris contents, anoxia may be associated with the impacted areas (Anonymous 1967, Harman et al. 1974a, 1977b). Increased biological oxygen demands, low pH and greater toxicity caused by hydrogen sulfide and methane gas may be responsible for reduced benthic macrofauna in isolated instances (Bagge 1969, Pratt et al. 1973). Epifamo et al. 1975 and Theede et al. 1969 have demonstrated varying resistances to marine clams and opportunistic worms to H_2S concentrations. The impact of oil and grease in dredged material has not been documented as a significant factor influencing recolonization. However, studies of cronic effects of oil spills suggest the potential problems of oil tainting of shellfish, fish and clams (Blumer et al. 1970, Blumer 1971, Nitta et al. 1965). Thus, the presence of oil in the dredged Duwamish River disposal material may have some impact on the benthos of this study. Uptake of heavy metals from sediment has been deomnstrated by Renfro, 1973, Bryan 1971, Bryan and Humerstone, 1971 and Phelps et al. 1975. Slowey et al. 1976 indicates that iron, manganese and zinc were taken up from sediment by some benthic organisms. However, toxic heavy metals took on ambient concentrations in their tissues and exhibited their ability to cleanse or reduce these increased concentrations when returned to sediment low in these metals. Engler (1977) concludes that increased toxic heavy metal uptake by organisms due to dredging will generally be imeasurable or

have no impact. The influence of pathogens in the dredged sediment has not been reported.

28. The literature indicates that when volatile soldis exceed 10 to 15 percent benthic populations will be inhibited (O'Neal et al. 1971, Anonymous, 1967). However, these studies do not demonstrate cause and effect. Chang and Levings, 1976, in laboratory tests indicated most organisms avoid wood substrates. McDaniel (1973) indicates that wood and log debris are used for shrimp protection, but also demonstrated that wood debris appears to hinder deposit feeding and tube building activities. Decline in worm tubes in areas of high debris was documented at a deep water disposal site and near pulp mill sludge deposits (Harman et al. 1974a, 1977b). Wood may also favor some sessile organisms in providing attachment sites where none formerly existed (McDaniel 1973, Pease 1974).

29. The ability of benthic organisms to burrow out of the dredged material disposal overburden is reviewed by Keck et al. 1976, Kranz 1974, Saila et al. 1971, and Stanley 1970. In Puget Sound scuba divers observed geoducks that were buried by as much as 1 m later forming blow holes Goodwin (1973). Kranz 1974, Slotta and Williamson 1974 and Mauer et al. 1974, indicate that epifaunal suspension feeders, mucous tube feeders and labial palp deposit feeders suffer the highest mortalities when buried with sediment. In general, large-size organisms have a greater escape percentage per depth burial. Stanley 1970, Pettibone, 1963, and Bousefield 1970 discuss the influence of clams and polychaete morphology in their ability to burrow through the disposal overburden. Glude 1954 indicates that survival is inversely proportional to the depth of burial that juveniles are more adversely affected than adults and that mortality increases with increased silt content. Keck et al. 1976, summarizes that the rate of recovery is determined by the morphology of the organism, its life style and the degree of difference in the disposal substrate and the predisposal substrate.

Community resilience studies

30. Most disposal and dredge studies were not designed to study or did not discuss those factors outlined by Sanders 1968 that influence community sturcutre or species diversity such as; (a) time, (b) spatial heterogeneity, (c) biological accommodation, (d) productivity, (e) predation

and (f) environmental stability.

31. The geologic age of the community or the degree of isolation may be an important factor in explaining differences between the younger glaciated Puget Sound habitats relative to the more older oceanic habitats of the Straits of Juan de Fuca and off the coast of Washington. Both meiofaunal and macrofaunal species composition do exist between these oceanic and estuarine habitats (Lie and Kelly 1970, Harman et al. 1974a). However, the influence of the degree of isolation (time) on community composition is difficult to ascertain.

32. Most investigations indicate or suggest the importance of recovery caused by spatial heterogeneity or such factors as (a) substrate variability, (b) bottom topography, (c) shoreline configuration and (d) proximity to other communities. Animal sediment relationships are well documented by Sanders 1958, McNulty et al. 1962, Rhodes and Young 1971. Johnson 1971 suggests that "species low in order of succession are those species that are found more frequently in other substrates" and "mud species are better able to invade clean sands." The shoreline configuration and bottom topography influence on the areal distribution of the benthos is indicated by Harman et al. 1974b, 1977a.

33. The productivity theory was used to suggest that trophic level composition and benthic communities closely reflect the availability of food supply. Such increases in density and number of species have been found in Puget Sound on deltas formed by tidal channels and forset beds of river deltas where high amounts of organic matter accumulate (Harman et al. 1977b). Low food supplies may result in low biomass and low species diversity (Sanders 1958, Driscoll 1967). However, Young 1968 indicates that areas of high food supply still may have no suspension feeders due to the high amounts of suspended sediment or high turbidity.

34. The predation theory has been used by Dayton and Hessler 1972 to suggest that "non-selective predation reduces competition between species thereby allowing more species to coexist". in deep habitats thereby increasing "the community diversity." However, Grassle and Sanders 1973 disagree with this concept for deep habitats "rapid cropping would result

in rapid extinction of species with relative low reproductive rates". Studying "class size" or age structure of clam and worm communities is generally not considered in most dredge and disposal studies. Stomach analyses of fish and other organisms were not used in most dredged material disposal studies to suggest selective feeding or food webs.

35. An increasing emphasis is given to the degree of biological accomodation or degree of biological interaction between species in influencing community structure. Recent efforts have been made to assess the role that suspension feeders, deposit feeders and tube builders play in competition for space. Rhodes and Young 1970 present evidence that the "reworking of muds tends to discourage the settlement and survival of early juvenile stages of suspension feeders." They contend that the "stability of the sea floor (sediment) largely controls feeding activities of the mud deposit feeders". Woodin, 1974, 1975, 1976, and Woodin and Yorke 1975, demonstrated how tube building organisms limited the mobility of deposit feeders through experiments removing tube builders and subsequent observation of niche replacement by motile deposit-feeding worms. Commensal relationships are more typical of diverse communities. Rhodes and Young, 1971 document the dependence of sabellid worms on a holothuroid activity. Partial removal of organisms through disposal activity may have a significant impact on the rate and nature of recovery when bottom invertebrate larvae are fed upon by the remaining predisposal organisms.

36. Environmental stability theories suggest declines in diversity in areas of increased sea bottom stress such as in river habitats where eurytopic species prevail (Sanders 1968). Conversely, more diverse communities are found in more stable habitats such as those of the deep-sea or tropical areas. The ability of communiites to rebound from environmental damage (community resilience) is thought to decrease with increasing diversity or environmental stability (Watt 1964, Dayton 1972, May 1973, Holling 1973, Goodman 1975). Thus, recovery in deep-sea areas is further discouraged by the lack of opportunistic species and the presence of benthic organisms that would have small brood sizes, old age class structures, and slow growth rates (Grassle and Sanders 1973). These characteristics would suggest the characteristics of a "equilibrium

community" or a "climax community." McCall 1977 characterizes equilibrium species (climax species of this study) as those with (a) few reproductions per year (b) low recruitment (c) slow development (d) late colonizers and (e) low death rate. He also defines opportunistic species as having opposite characteristics from the aforementioned equilibrium species. Grassle and Grassle 1974 defines opportunistic species as those having (a) high larvae ability, (b) large population size, (c) early maturation, (d) ability to increase rapidly and (e) high natural mortalities. Sanders 1968 suggests that "in predominately physically controlled communities there is no close coupling of a species to its environment." Johnson 1973 suggests that regional studies may indicate communities with different disturbance histories resulting in patches or mosaics or community structures in different succession stages. In this study climax species is used instead of equilibrium species since predictable progressive species replacement occurs in the recolonization of disturbed habitats toward species adapted to non-stressed conditions yet abundances of opportunistic species as well as climax speices may be in equilibrium to variously stressed habitats.

Benthic studies in Puget Sound

37. Most studies in Puget Sound are mainly seasonal studies designed to detect changes in community structure and species composition and to assess statistical approaches to community characterization or evaluation. Lie (1968) lists the benthic species of central Puget Sound and describes eight stations in terms of number of species and concentrations. Lie and Evans 1973 in studies of long-term variability, indicate small annual variations in species richness with the same species not always present. They suggest that Puget Sound diversity is high for similar latitudes. Lie and Kelley, 1970 utilized statistical methods in grouping crustaceans, eulamellibranchs and echinoderms. Standing crop biomass of Puget Sound and off the coast of Washington are described by Lie and Kisker, 1970. Species lists of the benthic macrofauna and megafauna off the coast of Washington are described by Carey, 1972, Lie and Kisker, 1970 and Pereyra and Alton 1972. Nichols (1970) describes changes of polychaete

populations between closely spaced stations in order to assess the relative continuum of organism distribution existing between depths or substrates types. Distribution charts of sediment, microbiogenic sediment components, and macrofauna for central Puget Sound have been made by Shoreline Community College; these include studies of Elliott Bay (Harman et al. 1974b), estuaries adjacent to Shilshole Bay and associated Seattle sewer outfall (Harman et al 1977 a, b). In Port Gardner and Everett Harbor detailed seasonal studies have been made of the benthos adjacent to the deep water and sulfite liquor portals (Anonymous 1967, Kisker 1976, Malkolf 1976). Many of the species found in Elliott Bay are also described in intertidal studies of Puget Sound and the San Juan Island area (Nyblade 1975, Webber 1975, and Armstrong et al 1976).

Summary

38. Benthic populations may be affected by dredging or disposal, however, fish, zooplankton, phytoplankton, and planktonic larvae appear to be unaffected. The immediate impact of the dredging and the disposal caused immediate short term declines in the benthic macrofuanal concentrations, number of species and biomass. Recovery is rapid in those areas with high degree of water turbulence caused by wave or tidal activity, especially in nearshore sandy habitats or areas of substrate instability. Slower recoveries occur in the more stable substrates, protected or deep-water habitats. Most studies indicate two phases of succession: an early phase dominated by opportunistic species, and a latter phase characterized by the readjustment of predisposal occupants. In most of the turbulent shallow habitats fish, crustaceans and larger organisms are normally first to recolonize the disposal sites. The rate of succession is typified by fish returning in minutes, crustaceans returning in hours, and opportunistic polychaetes recolonizing within days or months. Only a few species can burrow and resurface through 20 cm of disposal overburden. Suspended sediment and water column chemical constituent changes caused by dredging or disposal appear to have very little effect on the recolonization of disposal sites. Annoxia in the sediment may restrict recolonization, but increased hydrocarbon

and heavy metal concentrations does not appear to be a serious factor in the recolonization of disposal sites. In the shallower habitats, crustaceans appeared to be more important as recolonizers, while in the deeper habitats polychaetes seem to dominate. Tube-dwelling polychaetes or amphipods may limit the activity or distribution of motile polychaetes. In shallow water turbulent or unstable habitats most mollusks are more tolerant of dredging and disposal activity than polychaetes. Table 1 summarizes the reported early colonizers and opportunistic species.

Table 1

Reported Early Colonizers and Opportunistic Species

Reference	Study Area	Species
Grassle & Grassle 1974	Falmouth Ma. oil spill	Capitella capitata, Polydora ligni, Syllides verrilli, Microphthalmus aberrans, Strebliospio benedicti, Mediomastus ambiseta.
Reish 1962	Southern Calif. Dredge Boat Harbor	C. capitata, P. ligni
Wass 1967	Alamitos Bay Southern Calif.	C. capitata, P. ligni, S. benedicti, Nereis succinea.
Tulkki 1968	Gothenberg Harbor Sweden, pulp mill	C. capitata, P. ligni, N. diversicolor, Scolelepis fuliginosa
Rosenberg 1972	Swedish fjord pulp mill	C. capitata, S. fuliginiosa Polyphysia crassa, Glycera alba, Chaetozone setosa, Heteromastus filiformis
Dean & Haskin 1974	Raritan River Estuary Sewer disposal	C. capitata, P. ligni, S. benedicti, N. succinea, Mya arenaria
Stephenson et al. 1975	Los Angeles sewer	C. capitata, N. procera, Shistomeringos longicornis
Pratt et al. 1973	Solid waste disposal	C. capitata, P. ligni, N. succinea, harpacticoid copepods
Dauer & Simon 1976	Florida beach red	P. ligni, Apoprionospio pygmea, Megalona pettiboneae
Saila et al. 1972	Rhoad Island Sound Disposal Study	Prionospio malmgreni, Tharyx acutus, Eteone longa, Pholoe minuta, Heteromastus filiformis
Mauer et al. 1974	Delaware Bay Disposal Study	C. capitata, H. filiformis, Spiochaetopterus oculatas, Chaetopterus variopedatus, S. benedicti, N. succinea, P. ligni, Mulinia lateralis

Table 1

concluded

Reference	Study Area	Species
Parr et al. 1974	Coos Bay Oregon Disposal Study	S. benedicti, C. ovincola, P. ligni, Scoloplos sp., Mya arenaria
Oliver et al. 1976	Montery Bay Harbor Disposal Study	C. capitata, Armanda brevis phoronid tubes, P. pygmea, P. cirrifera, G. brevipalpa Platynereis bicanaliculata
Richardson et al. 1976	Columbia River Disposal Study	Olivella sp., M. moesta alaskana, Magelona sacculata Haploscoloplos elongatus, cumacean species
This study	Elliott Bay Disposal study	Ammotrypane aulogaster, Polydora uncata, Amphicties scaphobranchiata, Eteone longa, Trichochaeta multisetosa, Aricidea longicornuta

PART II: REGIONAL SETTING OF STUDY AREA

39. The goals of this regional description of the study area are as follows:

- a. To demonstrate the influence of shoreline configuration, depth, and currents upon the ultimate settlement of sediment which in turn affects the benthic macrofauna and meiofauna.
- b. To indicate differences that exist between the benthic macrofauna in Elliott Bay compared to other areas of Puget Sound.
- c. To indicate the preferred Puget Sound habitats of species found in Elliott Bay.
- d. To indicate faunal distributions within the Duwamish River channel.
- e. To indicate which species are found in stress or non-stress areas in order to suggest potential opportunistic species or climax species.

40. The following discussion is based on a review of the literature as well as the incorporation of unpublished regional sediment meiofaunal and macrofaunal distribution charts that have been made by Shoreline Community College.

Bathymetry and Physiography

41. The great depths and lack of inner shelf within Elliott Bay and its relative isolation from the main Puget Sound waters suggest probable occurences of eddies and bottom sediments consisting of river muds and sands (Figure 3). Weak currents, the presence of eddies induced by the north flow of central Puget Sound water and topographic configurations of Elliott Bay and Shilshole Embayment are documented from observations of Puget Sound models (Duxbury 1976, Schell et al. 1975, Ebbesmeyer 1976). The seaward extension of the contours of the mouth of the Duwamish River where the experimental disposal site is located suggests the building up of the river's delta or the possible formation from earlier dredged material disposal activities when the Duwamish River channels were straightened. Charts made of Elliott Bay in 1908 (USCGS, 1908) show the dominance of tidal flats where Harbor Island now is located, as well as portions of

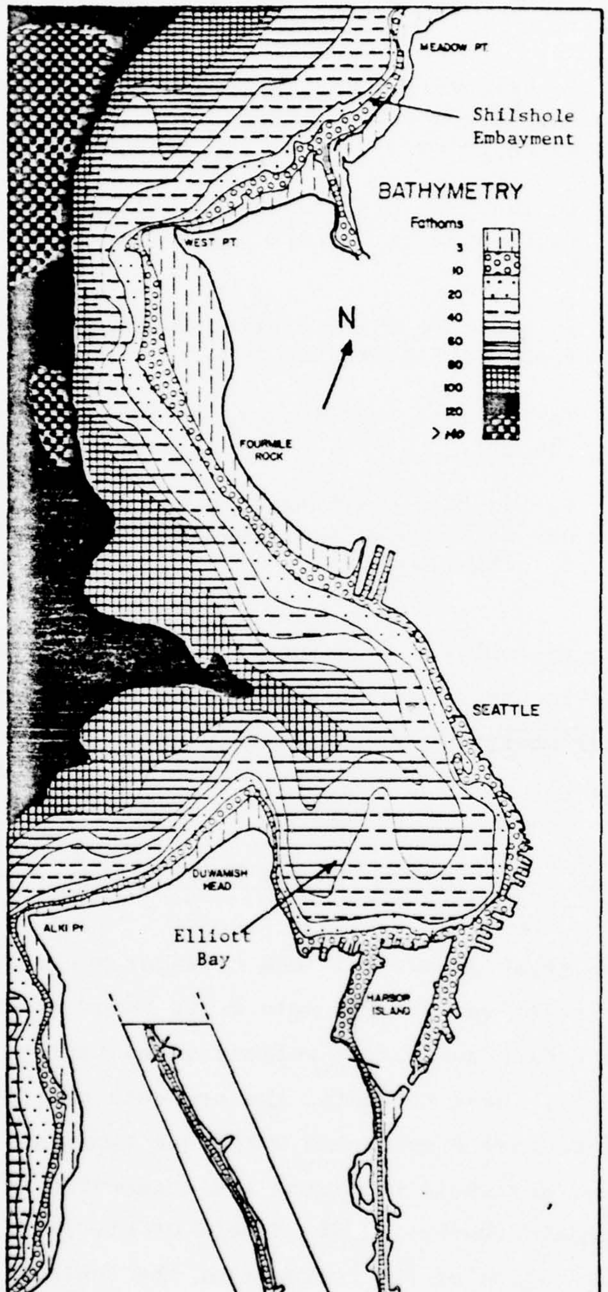


Figure 3. Bathymetric chart of Elliott Bay and Vicinity.

downtown Seattle. The Duwamish River, once meandering has been straightened by dredging, and the major portion of this dredged material has been used to fill in the former tide lands. An unusual extension of the 10-fathom contours in the eastern portion of the bay (off pier 67) reflects an earlier period when many of Seattle's hills were regraded. The entire shoreline of Elliott Bay has been reshaped by the construction of seawalls consisting of rock and cement or wood pilings.

42. The orientation of the Duwamish River east (Southeast Harbor) and west waterways suggests that the momentum of the river should move water towards the bay's eastern margin. Pavlou et al. 1973, Harman et al. 1974a, and Schell et al. 1976, confirms this river movement and indicates subsequent dilution of the eastern bays marginal waters based on salinity and sediment studies. The shape of Alki Point, West Point, and Duwamish Head suggests depositional and/or erosional headlands resulting from changing tide and wind-induced longshore currents that parallel the shorelines. The wide shelf outside Elliott Bay attests to this current action, producing a marine terrace with massive sand waves. The northward extension of the 50-fathom contours off West Point and Duwamish Head suggests the importance of this longshore and offshore reshaping of the central Puget Sound basin by displacement of shallow sediment into deeper habitats. The close proximity of the two submarine canyons that bifurcate the southern portion of Elliott Bay suggests the possible role of river debris introduced into the deeper basin areas by turbidity currents.

Atmosphere, Currents and Water Characteristics

43. The prevailing winds of the area are from the southeast during time of low pressure off the coast of Washington primarily during the winter. Northwest winds occur associated with high atomspheric pressures typical of the summertime. Precipitation over the area is relatively low (30 in. per year) compared to the adjacent areas where moisture-ladened air masses are forced up the sides of the Cascade and Olympic Mountains creating high percipitation (over 100 in. per year). The rainy season begins in October and continues until April with half of the annual percipitation falling in the 4-month period from October to January

(Puget Sound Task Force, 1970). Air temperature during the summer normally range in the 60's or 70's with an occasional temperature in the 90's while the normal winter temperatures are in the 40's and 50's although temperatures can occur below freezing.

44. Surface salinities taken whthin the central Puget Sound basin show the Duwamish River and Lake Union ship canal as major fresh water sources (Figure 4). This causes east-west differences in salinity in the central Puget Sound basin and as discussed later is also reflected in the microbiogenic sediment components and macrofauna distribution. The seasonal pycnocline is located at approximately the 2 to 5 fathom contour (4 to 10 m) with salanities and temperatures being uniformly constant below this depth (Collias et al. 1973). The apparent uniformity of the deep basin waters indicates the high amount of mixing of oceanic waters with estuarine waters. A continuous replacement of the deep basin water is enhanced by the tidal pumping action induced by the presence of Tacoma Narrows and Admiralty Sill (Barnes and Ebbesmeyer 1976). The presence of Admiralty Sill has a major impact on the difference in bottom waters that exists between Puget Sound and those found within the Straits of Juan De Fuca or off the coast of Washington (Figure 5). The sills at Admiralty Inlet and Tacoma Narrows also appear to have an effect on the current structure of central Puget Sound. Current studies indicate that a no net motion layer is produced at 25 fathoms (50 m) that corresponds roughly to the sill depths. Surface waters above this depth have a net seaward flow while those deeper flow inward into Puget Sound (Duxbury 1976, Barnes and Ebbesmeyer 1976). This no net motion layer seems to be significant in that it appears to be a possible factor that may control the depth distribution of the macrofauna in Puget Sound (Harman et al 1977a).

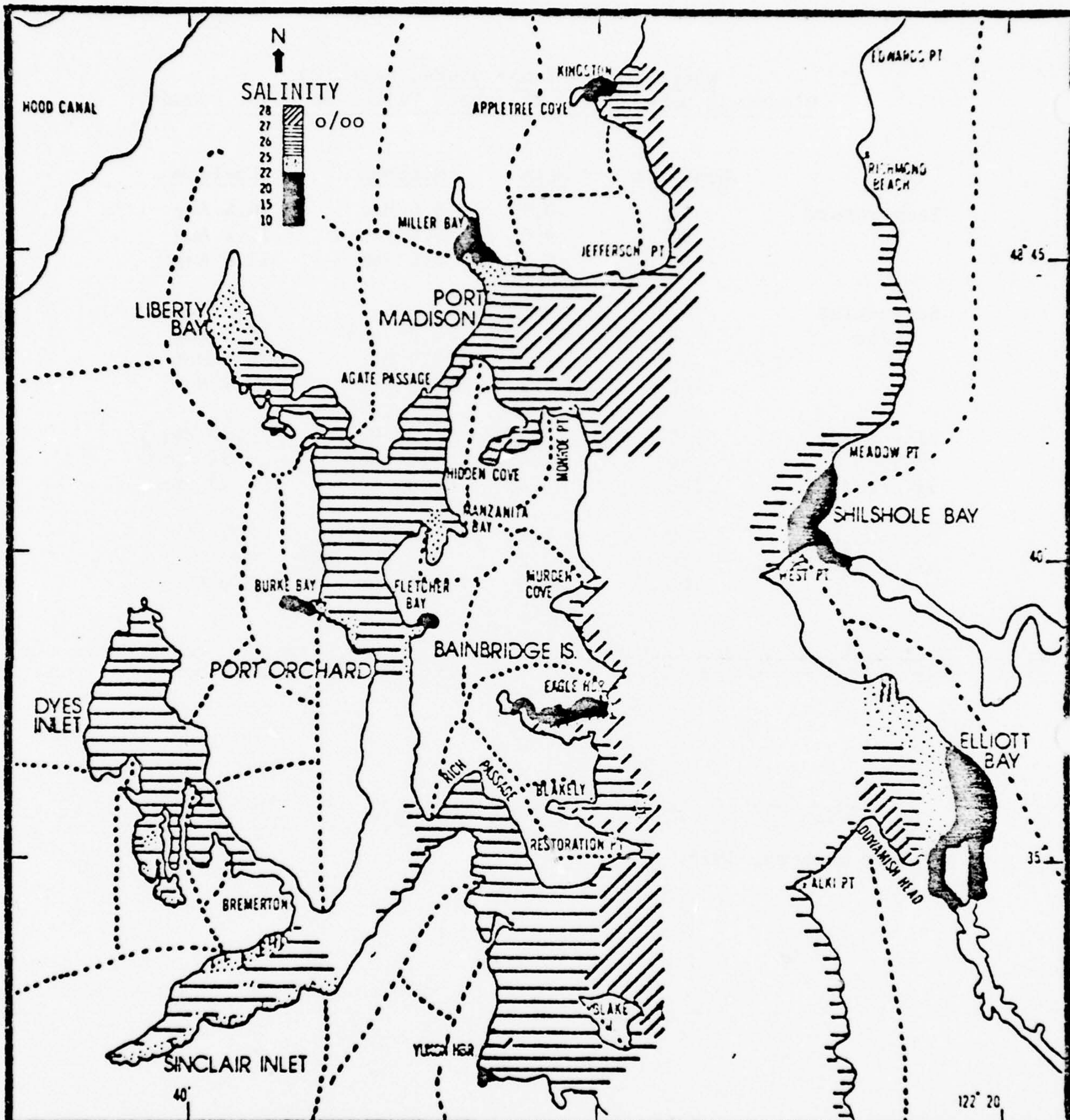
45. Table 2 summarizes the means, maximum and minimum values of temperature, salinity, dissolved oxygen, and phosphates based on data from Duxbury 1976. During wintertime surface water temperatures are markedly lower compared to deeper waters while during the summertime the surface temperature may reach 16°C compared to these deeper waters. A saline wedge extends 10 miles up the Duwamish River to turn basin number 6. The river dilutes the upper 1 to 3 m of the water column with salinities of 2 to 6 o/oo at the mouth with an overlying salt wedge having a

Table 2

Water Column Temperature, Salinity, Dissolved Oxygen, and Phosphate Values at Puget Sound*

	Depth, m	Mean	Minimum	Maximum
Temperature	0	10.2	6.6 Mar	16.6 Aug
°C	50	9.0	6.6 Feb	12.1 Aug
	100	8.8	6.6 Feb	11.6 Aug
Salinities				
o/oo	0	28.1	23.7 June	30.5 Oct
	50	29.8	29.0 Mar	30.6 Oct
	100	30.2	29.6 May	30.9 Nov
Dissolved	0	.53	.41 Oct	.70 May
Oxygen	50	.45	.34 Sept	.54 Apr
mg atom/lit	100	.45	.34 Sept	.43 Apr
Phosphates	0	1.8	.4 June	3.5 Feb
mg atom/lit	50	2.2	1.4 June	3.0 Dec
	100	2.0	1.4 June	3.0 Dec

* From Duxbury, 1976.



SALINITY AND DRAINAGE AREAS

Figure 4. Surface Salinities and Drainage areas of Central Puget Sound. Note east-west differences in salinities of the main Puget Sound Surface Waters, (after Harman and Sylwester 1974).

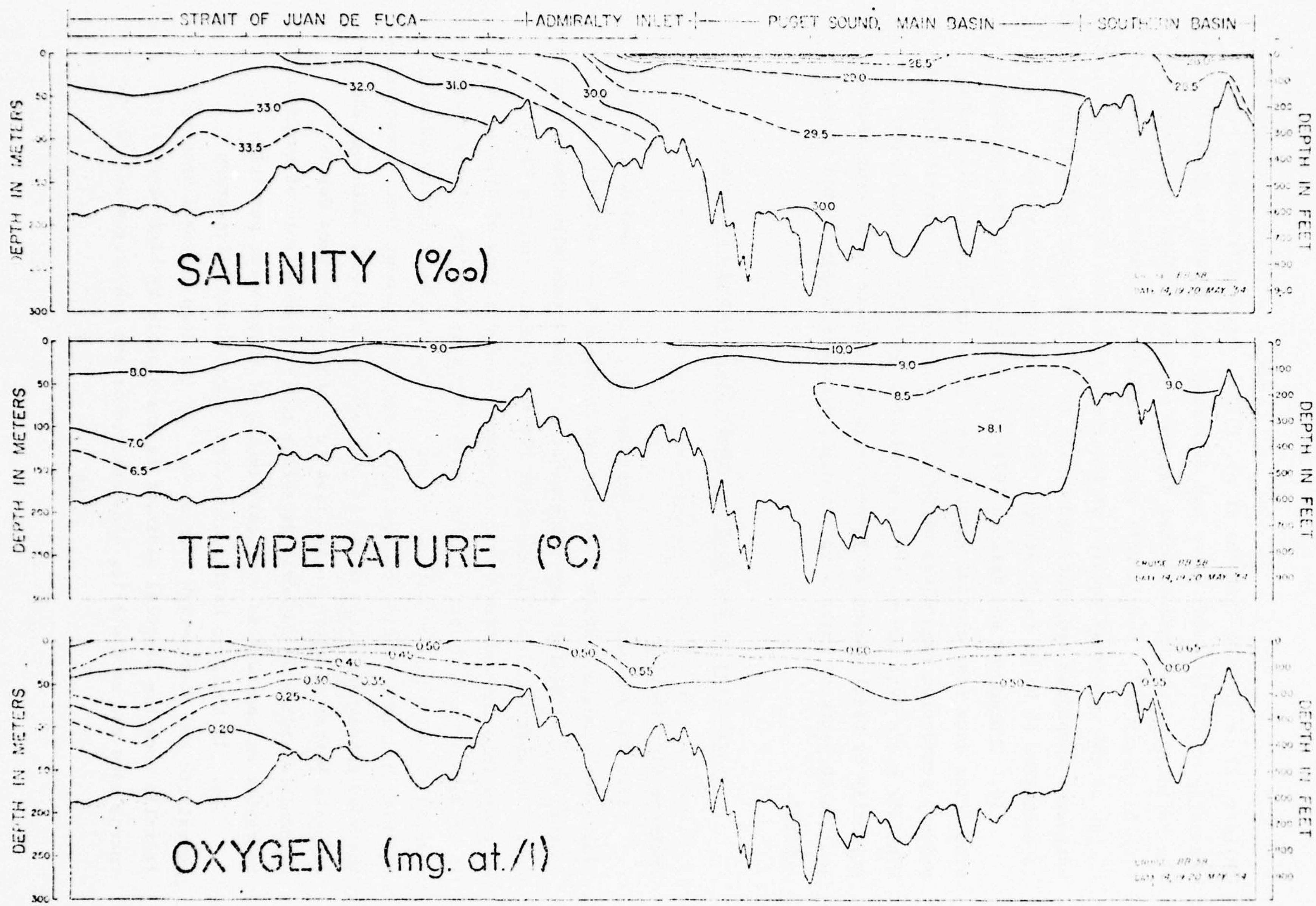


Figure 5. North - south vertical distribution of temperature, salinity, and oxygen showing influence of Admiralty Inlet on the water characteristics of Puget Sound main basin (from Collias et al. 1974).

salinity 27 to 28 o/oo (Stevens et al. 1972). Maximum freshwater discharge of the Duwamish River has decreased from 28,000 to 11,400 cfs since the building of the Howard Hansen dam while minimum values have increased from 81 to 158 cfs. Very little vertical mixing is reported to occur except at the uppermost portion of the river near turn basin 6. The estimated suspended sediment load is 125 to 375 tons/year and bed load is estimated to be 20 to 40 percent of the suspended load value.

46. Ebbesmeyer and Helseth 1977 have analyzed long term primary production data from central Puget Sound. They concluded natural annual primary production regardless of Seattle's sewer outfall contribution is high(342 g $c/m^2/yr$) due to strong persistant upwelling of nutrients primarily by tidal mixing at Tacoma Narrows. A 15 to 20 percent increase in 1 to 10 years of extreme values might possible be attributed to the outfall.

Distribution of Sediment and their Microbiogenic Components

Sediment distribution

47. The dominance of mud, vascular land plants, wood debris, and freshwater pennate diatoms indicates the Duwamish River influence on the eastern side of Elliott Bay (Figure 6a,b). Sandy muds with coarse wood debris suggest bed load transport of river materials from the East Waterway into the western submarine canyon and/or a lack of dilution of the rivers suspended load of plant-wood debris or possible former dredged materials. High concentrations of wood in the shallower depths enhances the high hydrogen sulfide content and blackened sediment that characterizes the wood entrapment sites adjacent to piers and pilings. Although the deep-sea bottom is close to the river's mouth, little wood debris accumulates below 50-fathoms, attesting to the greater role of horizontal transport as compared to vertical sinking of river-borne particles.

48. In the deep basins of central Puget Sound olive-green copralitic and diatom-rich muds occur. At the deep disposal sites off Fourmile Rock the disposal sediment is discernable by high amounts of coarse sand and wood debris, blackened color and a hydrogen sulfide (H_2S)

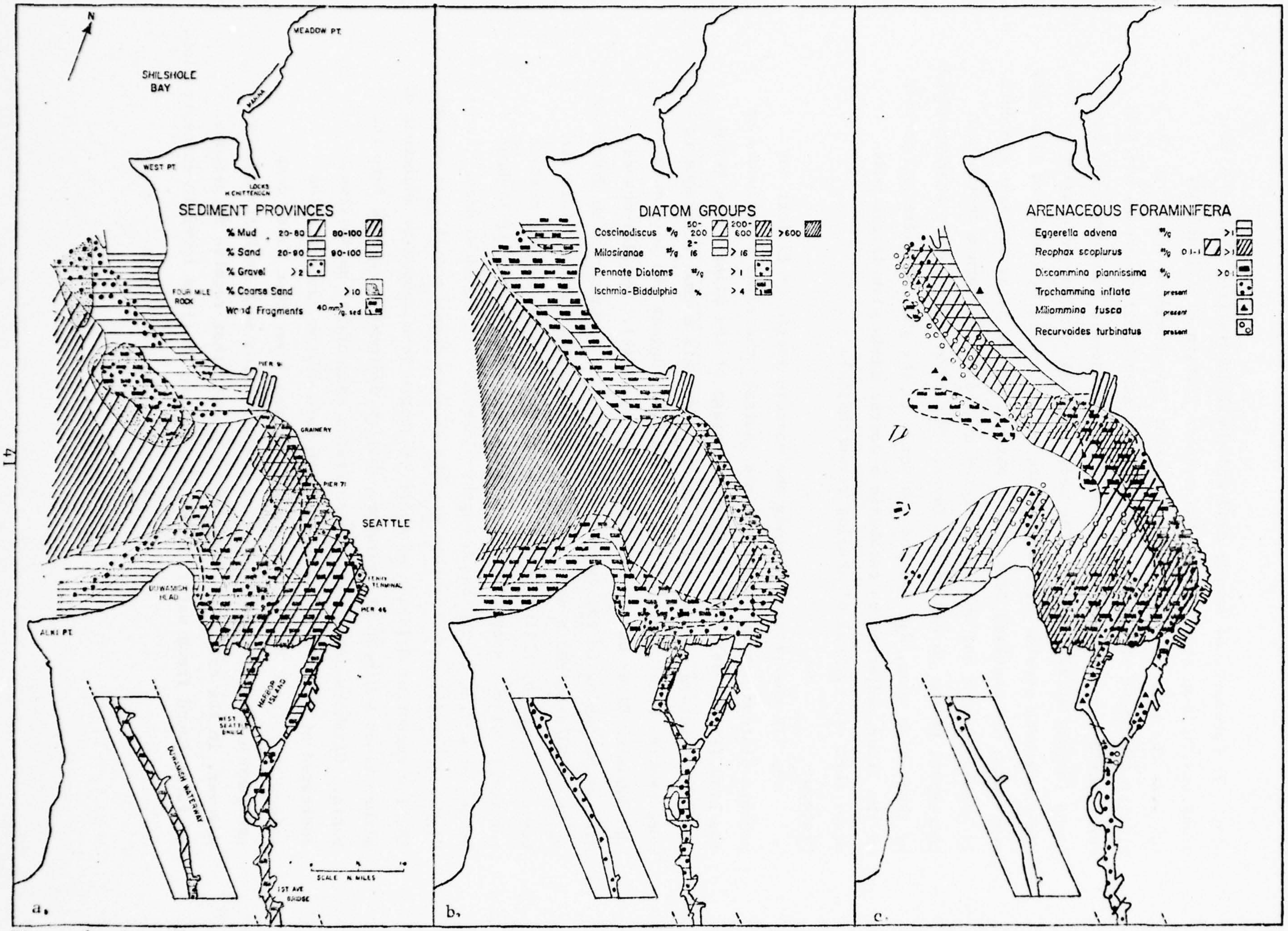


Figure 6a, b, and c. Distribution of sediment provinces (6a), diatom groups (6b) and arenaceous foraminifera (6c) in Elliott Bay and vicinity (After Harman et al. 1974a).

odor. The presence of coarse sand and shell debris from shallow living organisms in deep sediments in the western portion of Elliott Bay suggests the role of sediment displacement from Duwamish Head into the bay. Similar transport of shallow sediment into deep habitats occurs off West Point influencing the concentration of microbiogenic components and macrofauna (Harman et al. 1977a). The wave and tidal-influenced shallow shelf habitats outside Elliott Bay are characterized by compacted fine gray sands with mud contents less than 5 percent of the total sediment content. Increases of wood and mud are centered around the 25 fathom depths that correspond to the no net motion layer. The river sediment is characterized by their high wood, H_2S and mud content. In the shallow undredged portion of the river, adjacent to turnbasin 6 coarse sands with little muds occur that are typical of shallow river channels.

Diatoms

49. In the river and along the eastern margin of Elliott Bay pennate diatoms appear abundantly and indicate the river's influence on the area (Figure 6b). The higher percentage of the Milosiranae group along the eastern margin of Elliott Bay and their normal occurance in more brakish water areas of Puget Sound also suggest the influence of the Duwamish River on the bay (Harman et al 1974b). Angular-shaped diatoms belonging to the Ischmia-Biddulphis group appear to be displaced by currents from their normal, more saline shallow habitats into the western margin of Elliott Bay. The concentration of centric diatoms the Coscinodiscus group, increases with depth of water, with highest values occurring in the basin depths close to Alki-Duwamish Head. The high concentrations of centric diatoms in this deep basinal area suggest the low amount of dilution of their concentrations caused by additions of either river sediment or nearshore shallow sediment displaced into the basin. Offshore dilution of these diatom concentrations is also indicated at West Point. Off Duwamish Head diatom concentration values in Elliott Bay are two to three times lower than those deep embayments more distant from river sedimentation such as Port Madison. However, in the estuaries adjacent to Everett that receive 60 percent of Puget Sound fresh water, these diatoms are 20 times lower in concentration,

reflecting their dilution by river sedimentation or lower production rates. Centric diatoms belonging to the Asterostycus group and an unknown triangular-shaped Biddulphia species decline in frequency from the oceanic areas towards river-influenced areas of Elliott Bay. Schell et al. 1972 determined a sediment depositional rate for these basin depths of central Puget Sound that varies from 1 to 20 mm per year.

Arenaceous foraminifera

50. Arenaceous foraminifera are useful in defining habitats as well as suggesting areas of sea bottom stress or other factors such as river sedimentation or spatial heterogeneity that might be influencing their concentration in the bottom sediment. In central Puget Sound three faunal (and macrofaunal) depth zonations generally occur; shallow (0 to 15 fathoms), an intermediate (15 to 50 fathoms), and deep basin fauna (>50 fathoms) (Figure 6c). In the river and tide flats of the shallow habitats, *Trochammina inflata* and *Milliammina fusca* are abundant. These species can also occur in deeper areas reflecting sediment transport of river bed loads or recolonization over sea bottoms stressed by fresh water systems or sewer outfalls (Harman et al. 1977 a,b). Such deep water occurances of normally shallow foraminifera are found off Seattle's West Point sewer outfall, on the pulp mill influenced foreslopes of Snohomish River Delta, and within the Duwamish River, and in offshore areas of Elliott Bay.

51. In the more unprotected shallow habitats *Eggerella advena* and *Legenammina atlantica* are typically found while at intermediate depths *Reophax scorpiorus* and *Discammina plannissima* are more frequently found. High occurences of *R. scorpiorus* also occur in the deep waters adjacent to areas that provide high amounts of displaced shallow sediment and organic matter to the deeper areas of Puget Sound. The high abundance of these species adjacent to pier 91 and in the southwest corner of Elliott Bay suggests possible areas of organic enrichment.

52. Throughout most of the study area arenaceous foraminifera are relatively more abundant than calcium carbonate secreating foraminifera especially at the 25-fathom depth where wood debris and other organic matter appear to preferentially settle. The unusually low percentage of calcium carbonate secreting foraminifera in Elliott Bay suggests low pH

conditions that are normally associated with sediments having sediment interstitial waters with low oxygen and high H_2S contents that typify Elliott Bay habitats. Similar low frequencies of calcareous foraminifera are also found in the Everett Harbor and Port Gardner areas where wood fibers and sulfite liquors emanating from pulp mills are influencing factors. The presence of certain arenaceous foraminiferal species found in the Straits of Juan De Fuce and estuaries adjacent to Everett and their absence or rarity in the study area indicate qualatitive differences between central Puget Sound and Elliott Bay from the more oceanic or river-influenced areas.

Calcareous foraminifera

53. In the nearshore habitats of central Puget Sound and Elliott Bay large specimens of Elphidium selseyense occur (Figure 7a). Their abundance in the deep basin areas of central Puget Sound suggests the relative role of offshore displacement of shallow sediment into deep habitats. An excellent tracer of displacement of shallow microbiogenic sediment into deep water is Elphidiella hannai, which prefers shallow rocky or gravel substrates adjacent to breakwaters or in channels where tidal currents are strong. Their southerly displacement from West Point and towards the Fourmile Rock offshore basin area outside Elliott Bay correlates with studies suggesting southerly movements of deep basin waters into Elliott Bay (Schell et al. 1976). The general absence of this calcareous foraminifera in the eastern portion of Elliott Bay and its absence in the river-influenced habitats of Puget Sound indicates areas of suspended sediment deposition in the bay. Its higher occurence on the western margin of the bay is consistent with the higher salinities and coarser substrates found there.

54. In deep habitats influenced by nearshore sediment displacement Nonionella basispinata and Globulimina auricula are more frequent. Species absent from the study area but abundant within the Straits of Juan De Fuca and off the coast of Washington were Uvigerina juncea, Cassidulina californica, C. reflexa and Epistominella pacifica (Anderson 1969, Harman 1972). Thus, the sill at Admiralty Inlet that blocks deep oceanic water from Puget Sound appears to influence the species composition of deep habitats in Elliott Bay.

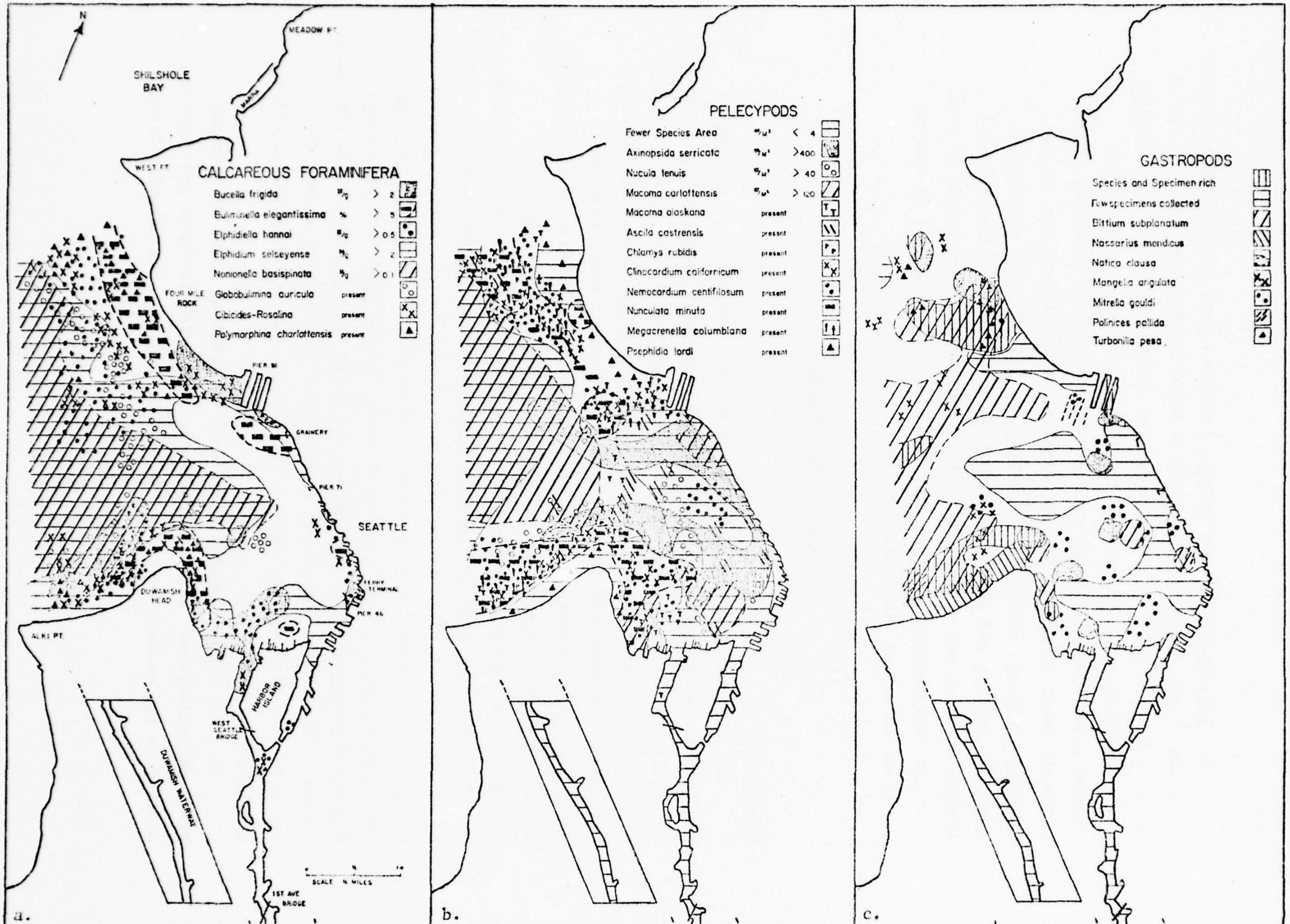


Figure 7 a, b, and c. Distribution of calcareous Foraminifera (a), pelecypods (b), and gastropod (c) in Elliott Bay and vicinity. Note low numbers of foraminifera and gastropods in the eastern portion of Elliott Bay.

55. Buliminella elegantissima, a species that dominates the calcareous fauna of the old West Point outfall sewer sludge deposits, was rarely found in Elliott Bay. Increasing amounts of H_2S and lower pH conditions in the sediment may have prevented the occurence of this thin wall foraminiferal species. Other species associated with turbulent waters typically found in tidal channels were absent in Elliott Bay, (e.g. Elphidium crispum, Glabrotella ornatissima, Trichohyalis columbiana, Cibicides lobatus and Rosalina columbiensis). Since the experimental dredged material was rich in H_2S calcareous foraminifera should be rare over the experimental disposal site and may prove excellent in tracing the areal extent of disposal material.

Benthic Macrofauna

Pelecypods

56. In the nearshore habitats of Elliott Bay that are influenced by river sedimentation, Macoma nasuta and Psephidia lordi are typically found (Figure 7b). However, these species decline in the upper portion of the Duwamish River channel and Macoma inconspicua becomes the dominant pelecypod. Outside Elliott Bay in the more current swept habitats Psephidia lordi dominates depths less than 15 fathoms while at intermediate depths Nemocardium centifilosum, Nunculata minuta and Megacrenella columbiana, and pectins dominate the pelecypod fauna. In the deeper basins M. carlottensis, Yoldia sp., Nucula tenuis and A. serricata dominate. Rarely occuring in Elliott Bay habitats are some of the dominant pelecypods of the shallow estuaries of central Puget Sound such as Ascila castrensis and Mysella tumida. Most commercial clams such as Saxidomus giganteus, Clinocardium nuttalli, Mya arenaria, and Protothaca stammina primarily occur outside Elliott Bay. Decreases in pelecypod concentrations over the Fourmile Rock disposal site define the impact area off disposal materials.

Gastropods

57. Gastropods typically decrease in subtidal areas of increased river sedimentation. Such a decline in the species richness and densities occured in the eastern portion of Elliott Bay and up the Duwamish River

(Figure 7c). High species richness and densities occur at the western margin of the bay and in shallow and intermediate habitats having coarse sediment. Mitrella gouldi and Odostomia sp. were most frequently observed in Elliott Bay. In the shallower areas outside the bay Nassarius mendicus is present but not in the large concentrations found in the more distant estuaries of Dyes Inlet and Liberty Bay. The dominant gastropod at the intermediate depth basin area outside Elliott Bay was Bittium subplanatum. This species is especially abundant off the old sewer sludge deposit in Shilshole Bay, off West Point. Its absence in Elliott Bay is suprising in view of the organic enrichment areas that occur in the bay. Intertidally, limpets, littorines, chitons, and the predatory snails Thais lamellosa and Polinices lewesii were frequently observed. Crepidula adunca, Trichotropis cancellata and Ceratsotoma foliatium, gastropods normally occupying Central Puget Sound's more gravelly, current-swept habitats, are rarely present in the subtidal habitats of Elliott Bay.

Polychaete and other worms

58. Within the uppermost portion of the Duwamish River channel, south of the 14th Avenue bridge, polychaetes are rare, Abarenicola pacifica, Nereis procera, Polydora uncata and Capitella capitata being most frequent (Figure 8b). In the tideflat portions of the river these species along with oligocahetes and Tharyx sp. are commonly found. Midway within the river channel, between the 1st Avenue bridge and the 14th Avenue bridge high densities of polychaetes occur; Cirratulus cirratus and Lumbrineris luti are most frequent. In the nearshore habitats of Elliott Bay, Glycinde picta, Armandia brevis, Nepthys ferruginea and Glycera capitata are characteristically found. Offshore, in the suspended load sea bottom influenced zone of Elliott Bay, Euclymene zonalis, Heteromastus filobranchus, Lumbrinereis luti, and Glycera capitata dominate. Less frequent larger specimens that contribute to high biomass when present are Pectinaria califoriensis, Laonice cirrata, Onuphis iridescens, Asychis similis, Praxilella gracilis, and the nemertean Cerebratulus sp. In the deep basin of central Puget Sound, Pectinaria califoriensis and Glycera capitata most characterize these habitats. Outside Elliott Bay in shallow unprotected habitats Platynereis bicaniculata, Chaetozone setosa, and Owenia fusiformis

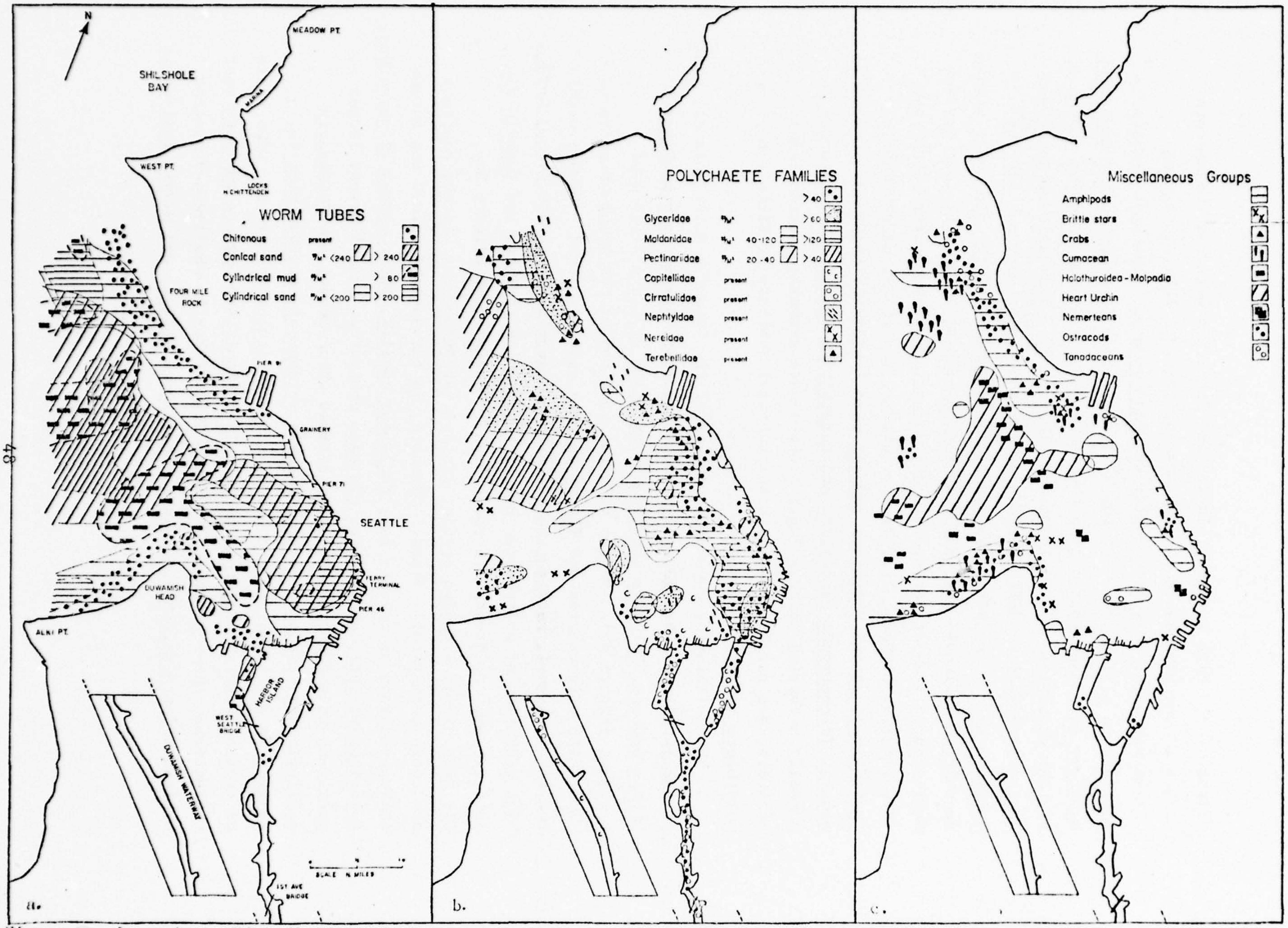


Figure , b, and c. Distribution of empty tubes (8a), p chaete families (8b), and miscellaneous macrofau (8c) organisms in Elliott Bay and vicinity (After Harman et al. 1974a).

are present along with the above nearshore fauna. Over the disposal site off Fourmile Rock polychaetes and other worms are less frequent even though there has been a recovery period of 20 years between disposal and sampling.

Empty tubes

59. In Puget Sound empty tubes of polychaetes, crustaceans, and other macrofaunal organisms often have higher concentrations than the living benthic macrofaunal organisms. Their accumulation in the bottom sediment aids in defining subtidal communities.

60. Empty chitinous worm tubes belonging to *Phyllochaetopterus prolifica* and *Spiochaetopterus costarum* were more frequent between the 5- and 25-fathom depths on the sandy shelves outside Elliott Bay (Figure 8a). In this zone sandy flexible tubes belonging to *Eucylmene zonalis* are most abundant in Elliott Bay where the Duwamish River suspended sediment influences the sea bottom. Conical sand tubes belonging to *Pectinaria californiensis* were more abundant in the deep basin areas or muddy habitats. Concentrations of pectinarian tubes appear to avoid stations where abundant wood debris occur. These tubes are also less frequent over the Fourmile Rock disposal site, an area of abundant wood debris. Large cylindrical mud tubes belonging to *Praxilella affinis* and *Asychis similis*, as well as large muddy to sandy tubes belonging to *Onuphis iridescens*, appear to be more frequent on the western portion of Elliott Bay. Although tube-dwelling tanadaceans (*Leptochelia* sp.) and amphipods (*Ampelisca* sp.) were abundant in the shallow areas their tubes were rarely sampled.

Crustaceans

61. Small crustaceans such as amphipods, tanadaceans, and ostracods were most abundant in the current swept, sandy, nearshore habitats outside Elliott Bay (Figure 8c). These crustaceans were more frequent on the western side of Elliott Bay compared to the eastern river-influenced river habitats. Large amphipods were frequently found in the upper most portion of the Duwamish River channel, a trend also observed in the Snohomish River. Scuba diver observations at Shoreline Community College have noted abudant shrimp in the nearshore habitats of Elliott Bay. Intertidal crabs such as *Hemigrapsus oregonensis* and *H. nudis* typically

occur between the +8 ft. and mean lower low water. Below this depth Cancer sp., Pugettia producta and P. gracilis are more typically found.

Other macrofaunal invertebrate organisms

62. In the deep basin areas beyond the experimental disposal site the heart urchin, Brisaster latifrons and the holothuroid, Molpadia intermedia dominate the biomass. The holothuroid appears to be influenced by river sedimentation, since it is abundant in the estuaries near Everett and sparse in the basin depths of central Puget Sound. In contrast, the heart urchin is less frequent in these river influenced habitats, being more dominant in the diatom-rich muds of the deep basins of central Puget Sound. At shallow and intermediate depths, Mediaster acqualis is the most frequent sampled starfish. Metridium senile is the most common sea anemone occupying the piling habitats while Anthopleura elegantissima is most frequent in the rocky habitats. Figure (9) summarizes many of the other commonly occurring intertidal and subtidal invertebrates and fish.

Fish and Shrimp

63. Demersal fish populations within Elliott Bay at the time of the winter pilot study (conducted by National Marine Fisheries) were dominated by dover, rock, flathead and english sole. Most pelagic species caught were shiner perch, pacific tomcod, and ratfish. Numerically dominant invertebrates collected by the otter trawl were the pink shrimp, Pandulus borealis. Greater numbers of fish and shrimp were captured along the west shore of Elliott Bay adjacent to Duwamish Head. Fish densities, species richness and community structure at West Point, Alki Point and within the Duwamish River are described by Miller et al. 1976. Most abundant in the otter trawls were rock sole, english sole and ratfish. The starry flounder was more frequent in the upriver portion of the Duwamish River channel as compared to the english sole, which were more abundant seaward of the 1st Avenue bridge. A similar trend was also observed bwtween marine and brackish water macrofauna. Starry flounder, longfin smelt, and Pacific staghorn sculpin are considered more euryhaline than english sole. Both beach and

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Pelecypoda (Bivalvia)	Axinopsida serricata	140.0 (.703)	47.0 (.214)	80.0 (.430)	89.0 (.4490)	176.0 (.739)	373.0 (1.436)	260.0 (1.233)	269.67 (1.1360)	187.0 (.563)	83.0 (.580)	78.0 (.297)	116.0 (.4800)	235.0 (.662)	247.0 (.798)	187.0 (.701)	223.00 (.7203)
	Cardiomya oldroydi		2.0 (.005)	3.0 (.259)	1.67 (.0380)	3.0 (.039)			1.00 (.0130)		1.0 (.001)	1.0 (.011)	0.67 (.0040)		3.0 (.025)	1.0 (.007)	1.33 (.0107)
	Compsomyax subdiaphana	1.0 (.041)			0.33 (.0137)	1.0 (.612)		1.0 (.115)	0.67 (.2423)							1.0 (.020)	0.33 (.0067)
	Lyonsia pugettensis						1.0 (.063)		0.33 (.0210)							1.0 (.010)	0.33 (.0030)
	Macoma alaskansis					1.0 (.077)	3.0 (2.329)	2.0 (.394)	2.00 (.9333)	2.0 (.177)	1.0 (.114)		1.00 (.0970)	2.0 (.001)			0.67 (.0003)
	Macoma carlottensis	20.0 (.558)	5.0 (.035)	16.0 (.238)	13.67 (.2770)	26.0 (.546)	56.0 (.519)	25.0 (.627)	35.67 (.5640)	19.0 (.033)	16.0 (.219)	29.0 (.451)	21.33 (.2343)	16.0 (.376)	30.0 (.130)	27.0 (.248)	24.33 (.2513)
	Macoma secta										1.0 (.284)		0.33 (.0947)				
	Nemocardium sp.		2.0 (.090)		0.67 (.0300)	1.0 (.019)	1.0 (.145)		0.67 (.0547)	3.0 (.275)		1.0 (.167)	1.33 (.1473)				
	Nucula tenuis	2.0 (.040)		3.0 (.033)	1.67 (.0243)	1.0 (.087)	5.0 (.263)	3.0 (.011)	3.00 (.1203)	3.0 (.209)	2.0 (.144)	2.0 (.116)	2.33 (.1563)	9.0 (.422)	4.0 (.183)	9.0 (.490)	7.33 (.3650)
	Nuculana minuta	5.0 (.143)	3.0 (.109)	4.0 (.037)	4.00 (.0963)	4.0 (.176)	12.0 (.233)	6.0 (.020)	7.33 (.1430)	6.0 (.160)	4.0 (.066)	3.0 (.071)	4.33 (.0990)	4.0 (.060)	4.0 (.040)	2.0 (.004)	3.33 (.0347)
	Pandora filosa					1.0 (.025)	1.0 (.034)		0.67 (.0197)	1.0 (.039)			0.33 (.0130)		1.0 (.014)		0.33 (.0047)
	Paravalucina tenuisculptis	2.0 (.934)			0.67 (.3113)										2.0 (.390)		0.67 (.1300)
	Yoldia sp.							1.0 (.001)	0.33 (.0003)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

		Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ERRANTIA																	
	Density	7.0	7.0		4.65	12.0	24.0	8.0	14.66	9.0	12.0	7.0	9.32	7.0	6.0	11.0	8.00
	Biomass	.911	.082		.3316	.100	.268	.177	.1818	2.529	.237	.069	.9449	.377	.568	.138	.3611
	Number of species	6.0	4.0		3.33	5.0	5.0	5.0	5.00	7.0	6.0	4.0	5.67	4.0	4.0	6.0	4.67
SEDENTARIA	Density	5.0	2.0	1.0	2.65	6.0	15.0	9.0	9.98	13.0	2.0	2.0	5.66	15.0	4.0	5.0	8.00
	Biomass	.317	.628	.060	.3350	.083	1.026	.479	.5293	.1920	.020	.172	.1280	1.253	.085	.138	.4920
	Number of species	3.0	2.0	1.0	2.0	3.0	6.0	6.0	5.0	3.0	2.0	2.0	2.33	5.0	2.0	4.0	3.67
GASTROPODA	Density	1.0		1.0	0.67	2.0	1.0	6.0	3.00	4.0	3.0		2.33	10.0	6.0	8.0	8.00
	Biomass	.080		.010	.0300	.001	.098	.009	.036	1.468	.087		.5184	.195	.101	.006	.1007
	Number of species	1.0		1.0	0.67	1.0	1.0	1.0	1.0	3.0	2.0		1.67	4.0	3.0	1.0	2.67
Pelecypoda	Density	170.0	59.0	106.0	111.68	214.0	452.0	297.0	321.00	221.0	108.0	114.0	147.65	266.0	291.0	228.0	261.65
	Biomass	2.419	.453	.997	1.2896	2.320	5.022	2.401	3.2477	1.456	1.408	1.113	1.3256	1.521	1.580	1.480	1.5267
	Number of species	6.0	5.0	5.0	5.33	9.0	8.0	7.0	8.00	7.0	7.0	6.0	6.67	5.0	7.0	7.0	6.33
TOTAL	Density	183.0	68.0	108.0	119.66	234.0	492.0	320.0	348.64	247.0	125.0	123.0	164.97	298.0	307.0	252.0	285.65
	Biomass	3.727	1.163	1.067	1.9856	2.504	6.414	3.066	3.9948	5.645	1.752	1.354	2.9169	3.3460	2.334	1.762	2.4805
	Number of species	16.0	11.0	7.0	11.33	18.0	20.0	19.0	19.00	20.0	17.0	12.0	16.33	18.0	16.0	18.0	17.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 Febraury 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Arabellidae	Notocirrus californiensis									1.0 (.110)			0.33 (.0367)				
Glyceridae	Glycera americana														1.0 (.118)		0.33 (.0393)
	Glycera capitata	3.0 (.122)	3.0 (.015)	2.0 (.094)	2.67 (.0770)	2.0 (.015)	2.0 (.004)	1.0 (.004)	1.67 (.0077)	2.0 (.037)	3.0 (.085)	3.0 (.050)	2.67 (.0573)	2.0 (.013)	5.0 (.042)	1.0 (.012)	2.67 (.0223)
Goniadidae	Glycinde picta			1.0 (.049)	0.33 (.0163)	1.0 (.013)		1.0 (.002)	0.67 (.0050)	2.0 (.082)			0.67 (.0273)				
Lumbrineridae	Lumbrineris bicirrata			1.0 (.079)	0.33 (.0263)	1.0 (.005)			0.33 (.0017)								
	Lumbrineris zonata		3.0 (.004)		1.00 (.0013)												
	Lumbrineris luti	3.0 (.004)		5.0 (.025)	2.67 (.0097)	1.0 (.006)			0.33 (.0020)		3.0 (.012)	2.0 (.020)	1.67 (.0107)		2.0 (.003)		0.67 (.0010)
	Lumbrineris brevicirra			1.0 (.079)	0.33 (.0263)												
Nephtyidae	Nephtys ferruginea	3.0 (.021)	2.0 (.010)	3.0 (.018)	2.67 (.0163)	1.0 (.041)		1.0 (.001)	0.67 (.0140)	1.0 (.009)	1.0 (.009)	3.0 (.042)	1.67 (.0200)				
Onuphidae	Onuphis iridescens		1.0 (.001)	2.0 (.096)	1.0 (.0323)	1.0 (.050)			0.33 (.0167)		2.0 (.068)		1.67 (.0227)	2.0 (.015)	2.0 (.128)	1.0 (.030)	1.67 (.0577)
Phyllodocidae	Eteone sp.	1.0 (.005)			0.33 (.0017)												
	Phyllodoce groenlandica										1.0 (.015)		0.33 (.0050)				
Polynoidae	Polynoid sp.		1.0 (.005)		0.33 (.0017)		1.0 (.002)	1.0 (.002)	0.67 (.0013)								
Syllidae	Syllis sp.		2.0 (.002)		0.67 (.0007)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 Febraury 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Heteromastus cf. filobranchus	8.0 (.143)	12.0 (.132)	9.0 (.203)	9.67 (.1593)	2.0 (.013)		4.0 (.072)	2.00 (.0283)	5.0 (.116)	13.0 (.132)	12.0 (.211)	10.00 (.1530)	3.0 (.010)	8.0 (.050)		3.67 (.0200)
Cirratulidae	Unknown sp.	1.0 (.002)			0.33 (.0007)												
Maldanidae	Euclymene zonalis	14.0 (.060)	2.0 (.003)	6.0 (.054)	7.33 (.0390)					3.0 (.113)	2.0 (.004)	1.0 (.010)	2.00 (.0423)		1.0 (.010)	1.0 (.004)	0.67 (.0047)
	Maldane glebiflex									1.0 (.012)			0.33 (.0040)				
	Nicomache lumbricalis	1.0 (.004)			0.33 (.0013)												
	Praxilella gracilis	1.0 (.095)			0.33 (.0317)	4.0 (.714)	1.0 (.076)	1.0 (.020)	2.0 (.2700)			1.0 (.600)	0.33 (.2000)	1.0 (.200)	1.0 (.043)		0.67 (.0810)
	Unknown sp.										1.0 (.050)		0.33 (.0167)				
Opheliidae	Travisia brevis			1.0 (.008)	0.33 (.0027)												
Orbiniidae	Scoloplos armigera	1.0 (.005)			0.33 (.0017)												
Oweniidae	Myriochele heeri	1.0 (.002)			0.33 (.0007)												
Pectinariidae	Pectinaria californiensis					1.0 (.028)		1.0 (.087)	0.67 (.0383)						1.0 (.034)		0.33 (.0113)
Spionidae	Laonice cirrata	2.0 (.918)	2.0 (.150)	1.0 (.005)	1.67 (.3577)		1.0 (.024)		0.33 (.0080)		1.0 (.011)	1.0 (.032)	0.67 (.0143)		1.0 (.138)	1.0 (.008)	0.67 (.0487)
	Prionospio malgreni			1.0 (.001)	0.33 (.0003)							1.0 (.015)	0.33 (.0050)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Terebellidae	Unknown sp.	1.0 (.009)			0.33 (.0030)												
Trichobranchidae																	
	Unknown sp.			1.0 (.038)	0.33 (.0127)												

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 Febraury 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca Pelecypoda (Bivalvia)	Ascila castrensis									1.0 (.256)			0.33 (.0853)				
	Axinopsida serricata	291.0 (1.565)	290.0 (1.765)	177.0 (.794)	252.67 (1.3747)	437.0 (2.176)	81.0 (.411)	162.0 (.795)	226.67 (1.1273)	73.0 (.416)	48.0 (.285)	90.0 (.456)	70.33 (.3857)	100.0 (.695)	88.0 (.611)	71.0 (1.031)	86.33 (.7790)
	Cardiomya oldroydi	3.0 (.037)	2.0 (.007)	1.0 (.007)	2.0 (.0170)	1.0 (.007)	1.0 (.002)		0.67 (.0030)	2.0 (.064)	1.0 (.014)		1.0 (.0260)	1.0 (.018)		1.0 (.004)	0.67 (.0073)
	Compsomyax subdiaphana	4.0 (1.437)			1.33 (.4790)	1.0 (.013)	1.0 (.063)		0.67 (.0253)								
	Hiatella pholatus		1.0 (.004)		0.33 (.0013)												
	Lucinoma annulata					1.0 (.209)	1.0 (.348)		0.67 (.1857)						4.0 (8.521)		1.33 (2.8403)
	Lyonsia pugettensis	1.0 (.005)	1.0 (.009)		0.67 (.0047)												
	Macoma alaskansis	2.0 (1.480)	3.0 (.434)	1.0 (.266)	2.0 (.7267)	3.0 (.557)		2.0 (.768)	1.67 (.4417)						1.0 (.156)		0.33 (.0520)
	Macoma carlottensis	47.0 (.417)	69.0 (.541)	15.0 (.210)	43.67 (.3893)	53.0 (.758)	26.0 (.220)	45.0 (.365)	41.33 (.4477)	4.0 (.095)	6.0 (.068)	6.0 (.100)	5.33 (.0877)	14.0 (.118)	4.0 (.060)	10.0 (.128)	9.33 (.1020)
	Macoma secta					1.0 (.340)		3.0 (1.491)	1.33 (.6103)								
	Megacrenella columbiana	1.0 (.008)	2.0 (.110)		1.0 (.0393)			1.0 (.001)	0.33 (.0003)								
	Nemocardium sp.		1.0 (.099)	2.0 (.316)	1.00 (.1383)			2.0 (.421)	0.67 (.1403)						1.0 (.077)		0.33 (.0257)
	Nucula tenuis	10.0 (.260)	7.0 (.147)	11.0 (.195)	9.33 (.2007)	14.0 (.387)	3.0 (.109)	6.0 (.052)	7.66 (.1827)		1.0 (.018)		0.33 (.0060)	1.0 (.025)	4.0 (.138)		1.67 (.0543)
	Nuculana minuta	14.0 (.480)	20.0 (.325)	6.0 (.246)	13.33 (.3503)	7.0 (.311)	1.0 (.030)	10.0 (.459)	6.00 (.2666)			3.0 (.160)	1.00 (.0533)		2.0 (.134)	1.0 (.015)	1.00 (.0497)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.	2.0 (.001)	15.0 (.024)	2.0 (.001)	6.33 (.0087)	7.0 (.006)			2.33 (.0020)		2.0 (.004)		0.67 (.0013)				
	Bittium subplanatum	4.0 (.104)	2.0 (.066)	1.0 (.018)	2.33 (.0627)	2.0 (.069)			0.67 (.0230)		2.0 (.028)		0.67 (.0093)				
	Mitrella gouldi	1.0 (.001)	1.0 (.028)		0.67 (.0097)	7.0 (.326)			2.33 (.1087)	2.0 (.127)			0.67 (.0423)	3.0 (.123)			1.0 (.0410)
	Nassarius mendicus					2.0 (.515)	1.0 (.464)		1.00 (.3263)								
	Natica clausa													1.0 (.023)			0.33 (.0077)
	Oenopota sp.														1.0 (.004)		0.33 (.0013)
Opisthobranchia	Turbonilla sp.	1.0 (.001)			0.33 (.0003)					1.0 (.003)			0.33 (.0010)		2.0 (.016)		0.67 (.0053)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Pelecypoda (Bivalvia)	Pandora filosa	1.0 (.248)	1.0 (.023)		0.67 (.0903)	1.0 (.056)		2.0 (.045)	1.0 (.0337)								
	Paravalucina tenuisculptis	2.0 (.051)			0.67 (.0170)	1.0 (.032)			0.33 (.0107)		2.0 (.227)		0.67 (.0757)	4.0 (3.912)			1.33 (1.3040)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

		Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA																	
	Density	10.0	12.0	15.0	12.33	7.0	3.0	4.0	4.67	6.0	10.0	8.0	8.00	4.0	10.0	2.0	5.33
	Biomass	.152	.037	.440	.2099	.130	.006	.009	.0484	.238	.189	.112	.1797	.028	.291	.042	.1203
	Number of species	4.0	6.0	7.0	5.67	6.0	2.0	4.0	4.00	4.0	5.0	3.0	4.00	2.0	4.0	2.0	2.67
SEDENTARIA	Density	30.0	17.0	18.0	21.67	7.0	2.0	6.0	5.0	9.0	17.0	16.0	13.99	4.0	12.0	2.0	6.01
	Biomass	1.238	.293	.301	.6105	.775	.100	.179	.3446	.241	.197	.868	.4353	.210	.2750	.012	.1657
	Number of species	9.0	4.0	5.0	6.00	3.0	2.0	3.0	2.67	3.0	4.0	5.0	4.00	2.0	5.0	2.0	3.00
GASTROPODA	Density	8.0	18.0	3.0	9.66	18.0	1.0		6.33	3.0	4.0		2.33	4.0	3.0		2.33
	Biomass	.107	.118	.019	.0814	.916	.464		.460	.130	.032		.0539	.146	.020		.0553
	Number of species	4.0	3.0	2.0	3.00	4.0	1.0		1.67	2.0	2.0		1.33	2.0	2.0		1.33
Pelecypoda	Density	374.0	339.0	213.0	328.67	520.0	114.0	233.0	289.0	80.0	58.0	99.0	78.99	120.0	104.0	83.0	102.32
	Biomass	5.937	3.515	2.034	3.8286	4.846	1.183	4.397	3.4753	.831	.612	.716	.1197	4.768	9.697	1.178	5.2143
	Number of species	10.0	12.0	7.0	9.67	11.0	7.0	9.0	9.0	4.0	5.0	3.0	4.00	5.0	7.0	4.0	5.33
TOTAL	Density	422.0	446.0	249.0	372.00	552.0	120.0	243.0	305.0	98.0	89.0	123.0	103.33	132.0	129.0	87.0	116.0
	Biomass	7.442	3.955	2.794	4.7304	6.647	1.753	4.585	4.3283	1.440	1.030	1.699	1.3886	5.152	10.283	1.232	5.5560
	Number of species	27.0	25.0	21.0	24.34	24.0	12.0	16.0	17.33	13.0	16.0	12.0	13.33	11.0	18.0	8.0	12.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

		Replicate and Mean Density and Biomass*															
		Station 1,5,9,13,17				Station 2,6,10,14,18				Station 3,7,11,15,19				Station 4,8,12,16,20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
TOTAL (TABLE)	Density	1073.00	1131.0	987.0	1063.31	1535.0	1343.0	1426.0	1434.67	874.0	756.0	905.0	924.45	999.0	874.0	1440.0	1114.27
	Biomass	16.468	22.763	10.202	16.4713	22.090	18.384	19.384	20.1028	13.437	17.576	12.395	15.5613	16.126	22.423	14.272	17.6000
	Number of species	93.0	85.0	73.0	83.33	93.0	75.0	93.0	86.99	65.0	84.0	75.0	79.33	74.0	79.0	83.0	78.66

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 21				Station 22				Station 23				Station 24			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Lumbrineridae	_Lumbrineris zonata_	1.0 (.002)			0.33 (.0007)					1.0 (.001)			0.33 (.0003)				
Nereidae	_Nereis procera_									3.0 (.024)			1.00 (.0080)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 25				Station 26				Station 27				Station 28			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Lumbrineridae	Lumbrineris zonata	2.0 (.080)			0.67 (.0267)					1.0 (.016)			0.33 (.0053)				
Nereidae	Nereis procera	1.0 (.005)			0.33 (.0017)	1.0 (.002)			0.33 (.0007)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum Class Subclass Order Annelida Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 29				Station 30				Station				Station			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Polychaeta																	
Errantia																	
Lumbrineridae	*Lumbrineris zonata*	4.0 (.111)			1.33 (.0370)												
Nereidae	*Nereis procera*	1.0 (.141)			0.33 (.0470)	1.0 (.005)			0.33 (.0017)								

246

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

		Replicate and Mean Density and Biomass*															
		Station 21,25,29				Station 22,26,30				Station 23,27				Station			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
TOTAL (TABLE)	Density	9.0			3.00	2.0			0.67	5.0			1.67				
	Biomass	.339			.1130	.007			.0023	.041			.0136				
	Number of species	2.0			.67	1.0			0.33	2.0			0.67				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta	Unknown fragments		1.0 (.005)	1.0 (.160)	0.67 (.0550)	1.0 (.179)	1.0 (.182)	1.0 (.020)	1.0 (.1270)	1.0 (.051)	1.0 (.043)	1.0 (.018)	1.0 (.0373)		1.0 (.043)	1.0 (.012)	0.67 (.0183)
Sipuncula	Unknown sp.			2.0 (.194)	0.67 (.0647)												
Nemertea																	
Cerebratulus	Adult sp.		1.0 (.020)		0.33 (.0067)					1.0 (.506)			0.33 (.1687)		1.0 (.015)		0.33 (.0050)
	Juvenile sp.			1.0 (.003)	0.33 (.0010)			2.0 (.010)	0.67 (.0033)	2.0 (.045)			0.67 (.0150)				
Arthropoda																	
Crustacea																	
Malacostraca	Crabs **							1.0 (.012)	0.33 (.0040)								
	Shrimp									1.0 (.034)		2.0 (.645)	1.0 (.2263)				
Amphipoda		3.0 (.004)	2.0 (.016)	3.0 (.011)	2.67 (.0103)	4.0 (.012)	1.0 (.002)		1.67 (.0047)		3.0 (.014)	3.0 (.014)	2.0 (.0093)		3.0 (.011)	4.0 (.014)	2.33 (.0083)
	**Pinnixia	1.0 (.010)			0.33 (.0033)	1.0 (.013)			0.33 (.0043)								
	************																
	Density	4.0	4.0	7.0	5.0	6.0	2.0	4.0	4.0	5.0	4.0	6.0	5.0		5.0	5.0	3.33
	Biomass	.014	.041	.368	.1410	.204	.184	.042	.1433	.636	.057	.677	.4566		.069	.026	.0316
	Number of Species	2.0	3.0	4.0	3.0	3.0	2.0	3.0	2.67	4.0	2.0	3.0	3.00		3.0	2.0	1.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5: 1	2	3	x̄	Station 6: 1	2	3	x̄	Station 7: 1	2	3	x̄	Station 8: 1	2	3	x̄
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta	Unknown fragments	1.0 (.036)		1.0 (.040)	0.67 (.0253)	1.0 (.008)		1.0 (.058)	0.67 (.0220)		1.0 (.021)	1.0 (.136)	0.67 (.0523)				
Sipuncula								1.0 (2.121)	0.33 (.7070)							1.0 (.008)	0.33 (.0027)
Nemertea																	
Cerebratulus	Adult sp.	1.0 (.084)		1.0 (.041)	0.67 (.0417)			1.0 (.079)	0.33 (.0263)			1.0 (.019)	0.33 (.0063)	2.0 (.068)	1.0 (.201)		1.00 (.0897)
	Juvenile sp.			1.0 (.015)	0.33 (.0050)			2.0 (.045)	0.67 (.0150)								
Arthropoda																	
Crustacea																	
Malacostraca	Shrimp						1.0 (.224)		0.33 (.0747)	2.0 (.017)	1.0 (.008)		1.00 (.0083)				
Amphipoda	Amphipods	3.0 (.007)	10.0 (.031)	1.0 (.005)	4.67 (.0143)	1.0 (.005)	1.0 (.001)	2.0 (.009)	1.33 (.0050)	2.0 (.012)		1.0 (.004)	1.0 (.0053)	2.0 (.006)		3.0 (.011)	1.67 (.0057)
	************																
	Density	5.0	10.0	4.0	6.34	2.0	2.0	7.0	3.66	4.0	2.0	3.0	3.0	4.0	1.0	4.0	3.0
	Biomass	.127	.031	.101	.0863	.013	.225	2.312	.8500	.029	.029	.159	.0722	.074	.201	.019	.0981
Number of Species		3.0	1.0	4.0	2.67	2.0	2.0	5.0	3.0	2.0	2.0	3.0	2.33	2.0	1.0	2.0	1.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 9: 1	Station 9: 2	Station 9: 3	Station 9: $\bar{x}$	Station 10: 1	Station 10: 2	Station 10: 3	Station 10: $\bar{x}$	Station 11: 1	Station 11: 2	Station 11: 3	Station 11: $\bar{x}$	Station 12: 1	Station 12: 2	Station 12: 3	Station 12: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta	Unknown fragments					1.0 (.075)	1.0 (.009)	1.0 (.009)	1.0 (.0310)		1.0 (.059)		0.33 (.0197)		1.0 (.103)		0.33 (.0343)
Sipuncula	Unknown sp.						1.0 (.003)	1.0 (.003)	0.67 (.0020)								
Nemertea																	
Cerebratulus	Adult sp.					1.0 (.007)			0.33 (.0023)		5.0 (.512)	1.0 (.022)	2.0 (.1780)		1.0 (.107)		0.33 (.0357)
	Juvenile sp.					1.0 (.004)	1.0 (.004)	1.0 (.004)	1.00 (.0040)								
Arthropoda																	
Crustacea																	
Malacostraca	Shrimp			1.0 (.032)	0.33 (.0107)						1.0 (.035)		0.33 (.0117)	1.0 (.030)			0.33 (.0100)
Amphipoda	Amphipods	1.0 (.007)	1.0 (.001)	2.0 (.011)	1.33 (.0063)	4.0 (.012)	3.0 (.008)	3.0 (.008)	3.33 (.0093)		2.0 (.020)	3.0 (.010)	1.67 (.0100)	2.0 (.010)	3.0 (.013)	5.0 (.016)	3.33 (.0130)
Cumacea						1.0 (.003)			0.33 (.0010)								
*************																	
	Density	1.0	1.0	3.0	1.66	8.0	6.0	6.0	6.66		9.0	4.0	4.33	3.0	5.0	5.0	4.32
	Biomass	.007	.001	.043	.0170	.101	.024	.024	.0496		.626	.032	.2194	.040	.223	.016	.0930
	Number of Species	1.0	1.0	2.0	1.33	5.0	4.0	4.0	4.33		4.0	2.0	2.0	2.0	3.0	1.0	2.0

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13: 1	2	3	x̄	Station 14: 1	2	3	x̄	Station 15: 1	2	3	x̄	Station 16: 1	2	3	x̄
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta	Unknown fragments					1.0 (.240)	1.0 (.025)	1.0 (.053)	1.0 (.1060)	1.0 (.020)		1.0 (.042)	0.67 (.0207)	1.0 (.015)			0.33 (.0050)
Sipuncula	Unknown sp.						2.0 (.009)		0.67 (.003)		1.0 (.045)		0.33 (.0150)				
Nemertea																	
Cerebratula	Adult sp.													1.0 (2.525)	1.0 (.288)		0.67 (.9377)
	Juvenile sp.						2.0 (.031)	1.0 (.015)	1.0 (.0153)								
Arthropoda																	
Crustacea																	
Malacostraca	Shrimp									2.0 (.038)			0.67 (.0127)				
	*************																
	Density					1.0	5.0	2.0	2.67	3.0	1.0	1.0	1.67	2.0	1.0		1.0
	Biomass					.240	.065	.068	.1243	.058	.045	.042	.0484	2.540	.288		.9427
Number of Species						1.0	3.0	2.0	2.00	2.0	1.0	1.0	1.33	2.0	1.0		1.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	Station 17: 2	Station 17: 3	Station 17: $\bar{x}$	Station 18: 1	Station 18: 2	Station 18: 3	Station 18: $\bar{x}$	Station 19: 1	Station 19: 2	Station 19: 3	Station 19: $\bar{x}$	Station 20: 1	Station 20: 2	Station 20: 3	Station 20: $\bar{x}$
Annelida																	
Polychaeta	Unknown fragments	1.0 (.020)		1.0 (.005)	0.67 (.0083)	1.0 (.035)	1.0 (.052)	1.0 (.095)	1.00 (.0607)								
Sipuncula	Unknown sp.	1.0 (.008)			0.33 (.0027)		1.0 (.065)		0.33 (.0217)								
Nemertea																	
Cerebratulus	Adult sp.					1.0 (.041)		1.0 (.010)	0.67 (.0170)	1.0 (.079)			0.33 (.0263)	2.0 (.865)			0.67 (.2883)
	Juvenile sp.	1.0 (.002)	1.0 (.004)	1.0 (.005)	1.0 (.0037)	1.0 (.035)		1.0 (.020)	0.67 (.0183)					1.0 (.030)			0.33 (.0100)
Arthropoda																	
Crustacea																	
Malacostraca	Pinnixia						1.0 (.012)		0.33 (.0040)								
	Shrimp	1.0 (.015)			0.33 (.0050)						1.0 (.360)	2.0 (.083)	1.0 (.1477)				
Amphipoda	Amphipods	2.0 (.016)	7.0 (.005)	6.0 (.019)	5.0 (.0133)	2.0 (.006)		5.0 (.005)	2.33 (.0037)		1.0 (.005)	2.0 (.008)	1.00 (.0043)				
	Tanaidacea	1.0 (.002)		1.0 (.002)	0.67 (.0013)												
	************																
	Density Biomass	7.0 (.063)	8.0 (.009)	9.0 (.031)	8.00 (.0343)	5.0 (.117)	3.0 (.129)	8.0 (.130)	5.33 (.1254)	1.0 (.079)	2.0 (.365)	4.0 (.091)	2.33 (.1783)	3.0 (.895)			1.00 (.2983)
	Number of Species	6.0	2.0	4.0	4.0	4.0	3.0	4.0	3.67	1.0	2.0	2.0	1.67	2.0			0.67
	************																
Cumulative	Density	17.0	23.0	23.0	21.0	22.0	18.0	27.0	22.32	13.0	18.0	18.0	16.33	12.0	12.0	14.0	12.65
Cumulative	Biomass	.211	.082	.542	.8786	.675	.627	2.576	1.2926	.802	1.122	1.001	.9749	3.549	.781	.061	1.4637
Cumulative	Number of Species	12.0	7.0	14.0	11.0	15.0	14.0	18.0	15.67	9.0	11.0	11.0	10.33	8.0	8.0	5.0	7.00

Field and Laboratory Description of Sediment Grab Sample

Sampled 2,3,5 February 1976

	Station 1				Station 2				Station 3				Station 4			
	1	2	3	x	1	2	3	x̄	1	2	3	x̄	1'	2	3	x̄
pth	198	198	198	198.00	200	200	200	200.00	214	214	220	216.00	222	NR	NR	222.00
mple Volume - Litres	7.0	8.0	5.0	6.67	16.0	7.8	12.0	11.93	13.0	7.0	14.5	11.50	13.2	13.0	12.5	12.90
mple Residue ml/l	107.0	143.8	110.0	120.26	59.4	150.6	108.3	106.10	46.2	117.9	66.2	76.77	56.8	67.7	100.0	74.83
rcent Rock	99.0	52.6	50.0	67.20	35.0	40.0	55.1	43.37	9.9	10.0	79.9	33.27	50.0	42.5	7.5	33.33
lume Rock ml/l	106.0	75.5	55.0	78.83	20.8	60.3	59.6	46.90	4.6	11.8	52.9	23.10	28.4	28.8	7.5	21.56
rcent Wood & Fibers	1.0	47.5	90.0	46.17	5.0	77.5	44.1	42.20	74.8	64.9	10.5	50.06	59.1	72.5	42.4	58.00
lume Wood & Fibers ml/l	1.1	68.3	55.0	41.46	11.9	90.4	48.7	50.33	41.5	106.1	10.3	52.63	28.4	39.0	92.5	53.30
rcent Wood	1.0	30.0	80.0	37.00	5.0	60.0	34.1	33.03	59.9	64.9	.6	41.80	29.9	47.5	27.5	34.97
lume Wood ml/l	1.1	43.1	44.0	29.40	3.0	90.4	37.9	43.76	27.7	76.6	.4	34.90	17.0	32.2	27.5	25.56
rcent Fibers	0.0	17.5	10.0	9.17	0.0	17.5	10.0	9.17	14.9	0.0	9.9	8.32	29.8	25.0	14.9	23.27
lume Fibers ml/l	0.0	25.2	11.0	12.06	8.9	0.0	10.8	6.56	13.8	29.5	9.9	17.73	11.4	6.8	65.0	27.73
rficial Layer Thickness																
lor Sediment	B/G-b	B/g-b	B/g-b		B/g-b	B/g-b	B/g-b		B/g-b	B/b	B/b		B/g	NR	NR	
S Odor	S	S	NO		NO	NO	NO		NO	NO	NO		YES	NO	NO	
sociated Debris																
Oil														X		
Coal																
Seeds	X	X	X		X		X			X						
Metals																
Glass										X						
Brick																
Blue Clay		X														

Field and Laboratory Description of Sediment Grab Sample

Sampled 2,3,5 February 1976

	Station 5				Station 6				Station 7				Station 8			
	1	2	3	x	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
pth	198	200	198	198.67	200	200	200	200.00	206	206	212	208.00	214	214	214	214.00
mple Volume - Litres	5.0	12.0	6.0	7.67	11.0	15.0	8.5	11.50	8.0	6.0	6.0	6.67	6.0	13.0	14.0	11.0
mple Residue ml/1	100.0	129.2	158.3	129.17	150.0	113.3	166.5	143.27	115.6	146.6	150.0	137.40	116.8	55.4	71.4	81.17
ercent Rock	60.0	32.5	47.5	46.67	46.6	66.3	33.2	48.70	34.9	47.5	50.0	44.13	64.9	78.3	50.0	64.43
olume Rock ml/1	60.0	42.0	75.2	59.07	70.0	75.5	55.4	66.97	40.4	69.7	75.0	61.70	75.8	43.4	35.7	51.63
ercent Wood & Fibers	55.0	72.4	114.5	80.63	48.3	24.6	43.0	38.63	54.9	53.3	71.6	59.93	32.4	23.5	51.0	35.63
olume Wood & Fibers ml/1	40.0	87.2	83.2	70.13	80.0	37.8	110.9	79.23	75.1	77.0	75.0	75.70	40.9	11.6	35.8	29.43
ercent Wood	35.0	62.4	49.5	48.97	43.3	19.6	40.0	34.30	44.9	40.0	45.0	43.30	12.5	11.1	46.0	23.20
olume Wood ml/1	35.0	80.7	78.4	64.70	65.0	22.7	66.6	51.47	52.0	58.7	67.5	59.40	14.6	6.2	32.9	17.90
ercent Fibers	20.0	10.0	65.0	31.67	5.0	5.0	3.0	4.33	10.0	13.3	26.6	16.63	19.9	12.4	5.0	12.43
olume Fibers ml/1	5.0	6.5	4.8	5.43	15.0	15.1	44.3	24.80	23.1	18.3	7.5	16.30	26.3	5.4	2.9	11.53
rficial Layer Thickness																
lor Sediment	1tB/b	B/b	B/b		dkG/b	dkG/b	B/b		B/g/b	B/b	B/b		B/b	B/b	B/b	
S Odor	NO	NO	NO		NO	NO	S		YES	S	NO		NO	NO	S	
sociated Debris																
Oil																
Coal																
Seeds		X														
Metals																
Glass		X					X									
Brick																
Blue Clay																

251

Field and Laboratory Description of Sediment Grab Sample

Sampled 2,3,5 February 1976

	Station 9				Station 10				Station 11				Station 12			
	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
epth	194	194	194	194.00	198	196	196	196.67	210	208	210	209.33	210	198	208	205.33
ample Volume - Litres	2.5	6.0	9.0	5.83	5.0	8.0	7.0	6.67	4.5	6.0	5.0	5.17	10.0	7.5	8.0	8.50
ample Residue ml/l	130.0	58.3	33.3	73.87	170.0	171.9	92.6	144.83		108.3	196.0	152.15	95.0	146.7	169.0	136.90
ercent Rock	65.3	80.1	60.0	68.47	20.0	49.9	70.1	46.67		25.0	37.5	31.25	37.4	87.4	44.9	56.57
olume Rock ml/l	85.0	46.7	20.0	50.57	34.0	85.9	65.0	61.63		27.1	73.5	33.53	35.6	128.3	75.9	79.93
ercent Wood & Fibers	34.5	20.0	39.9	31.47	80.0	49.9	30.0	53.30		5.6	42.6	24.10	64.9	12.3	99.9	59.03
olume Wood & Fibers ml/l	45.0	11.7	13.3	23.33	136.0	85.9	27.9	83.27		81.2	122.5	101.85	61.7	18.3	92.8	57.60
ercent Wood	30.7	20.0	39.9	30.20	45.0	47.4	28.0	40.13		.7	42.5	21.60	52.5	9.4	49.7	37.20
olume Wood ml/l	40.0	11.7	13.3	21.67	76.5	81.6	26.0	61.37		75.8	83.3	79.55	49.9	13.9	8.4	24.07
ercent Fibers	3.8	0	0	1.27	35.0	2.5	2.0	13.18		4.9	.1	2.5	12.4	2.9	49.9	21.73
olume Fibers ml/l	5.0	0	0	1.67	59.5	4.3	1.9	21.90		5.4	39.2	22.30	11.8	4.4	84.4	33.53
rficial Layer Thickness																
lor Sediment	B/b	B/b	B/		1tB/dkG	1tG/dkG	B/dkG		1tG/dkG	1tG/dkG	1tB/dkG		1tB/dkG	1tG/dkG	1tG/dkG	
S Odor	YES	YES	YES		YES	YES	YES		YES	NO	NO		YES	NO	NO	
sociated Debris																
Oil							X								X	
Coal																
Seeds											X					
Metals																
Class															X	
Brick						X									X	
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 2,3,5 February 1976

	Station 13				Station 14				Station 15				Station 16			
	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
pth	180	182	180	180.67	188	184	186	186.00	190	198	190	192.67	202	202	200	201.33
mple Volume - Litres	6.5	3.0	3.5	4.33	4.5	3.0	5.0	4.17	9.5	10.0	5.0	8.17	8.0	8.0	7.5	7.83
mple Residue ml/1	392.0	366.7	571.4	443.37	266.7	166.7	145.0	192.80	73.7	157.0	120.0	116.90	56.3	75.0	40.0	57.10
rcent Rock	.1	62.5	40.0	34.20	29.9	79.6	80.0	63.17	40.0	10.0	60.0	36.67	49.9	80.0	10.0	46.64
lume Rock ml/1	3.9	229.2	228.6	153.90	80.0	133.3	116.0	109.77	29.5	15.7	72.0	39.07	28.1	60.0	4.0	30.70
rcent Wood & Fibers	80.9	37.4	60.0	59.43	69.7	20.6	20.0	36.77	59.9	90.0	40.0	63.30	50.9	20.0	80.0	50.30
lume Wood & Fibers ml/1	317.7	137.5	342.9	266.03	186.6	33.4	29.1	83.03	44.2	141.3	48.0	77.83	28.7	15.0	32.0	25.23
rcent Wood	.9	31.9	40.0	24.27	64.9	10.6	15.0	30.17	49.9	40.0	15.0	34.97	50.9	10.0	40.0	33.63
lume Wood ml/1	3.9	117.3	228.6	116.60	173.3	16.7	21.8	70.60	36.8	62.8	18.0	39.20	28.7	7.5	16.0	17.40
rcent Fibers	80.0	5.5	20.0	35.17	4.9	10.0	5.0	6.63	10.0	50.0	25.0	28.33	0	10.0	40.0	16.67
lume Fibers ml/1	313.8	20.2	114.3	149.43	13.3	16.7	7.3	12.43	7.4	78.5	30.0	38.63	0	7.5	16.0	7.83
rficial Layer Thickness																
lor Sediment	dkB/dkG	B/b	B/b		B/b	B/b	B/b		dkB/1tG	B/b	1tB/dkB		G/b	G/b	G/b	
S Odor	YES	YES	YES		YES	YES	NO		NO	NO	NO		YES	YES	YES	
sociated Debris																
Oil		X														
Coal																
Seeds	X															
Metals																
Glass	X	X														
Brick	X	X														
Blue Clay	X	X	X													

Field and Laboratory Description of Sediment Grab Sample

Sampled 2,3,5 February 1976

	Station 17				Station 18				Station 19				Station 20			
	1	2	3	x	1	2	3	x̄	1	2	3	x̄	1'	2	3	x̄
epth	186	176	170	177.33	212	222	190	208.00	160	160	165	161.67	160	198	192	183.33
ample Volume - Litres	8.0	4.5	4.0	5.50	8.5	9.0	7.0	8.17	8.0	7.0	9.0	8.00	7.5	8.0	7.0	7.50
ample Residue ml/1	65.6	44.4	50.0	53.33	123.5	127.8	71.4	107.57	150.0	214.3	122.2	162.17	120.0	59.4	257.0	145.47
ercent Rock	80.0	80.1	70.0	76.70	62.5	65.0	85.0	70.83	42.5	44.9	4.9	30.77	10.0	40.0	25.0	25.00
olume Rock ml/1	52.5	35.6	35.0	41.03	77.2	83.1	60.7	73.67	63.8	96.4	6.1	55.43	12.0	23.8	64.3	33.37
ercent Wood & Fibers	19.97	20.04	30.0	23.34	37.4	34.8	15.0	29.07	57.5	55.8	94.9	69.40	80.0	60.3	75.4	71.90
olume Wood & Fibers ml/1	13.1	8.9	15.0	12.33	46.3	44.7	10.8	33.93	86.3	117.9	116.1	106.77	96.0	35.7	192.9	108.20
ercent Wood	19.9	20.0	20.0	19.97	32.4	21.9	5.0	19.77	52.5	52.5	90.0	65.00	50.0	20.0	40.0	36.67
olume Wood ml/1	13.1	8.9	10.0	10.67	40.1	28.1	3.6	23.93	78.8	112.5	110.0	100.43	60.0	11.9	102.9	58.27
ercent Fibers	0	0	10.0	3.33	5.0	12.9	10.0	9.30	5.0	2.5	4.9	4.13	30.0	40.0	35.0	35.0
olume Fibers ml/1	0	0	5.0	1.67	6.2	16.6	7.2	10.00	7.5	5.4	6.1	6.33	36.0	23.8	90.0	49.93
urficial Layer Thickness																
olor Sediment	ltG/dkG	B/G	ltG/dkG		ltG/dkG	ltG/dkG	ltG/dkG		ltG/dkG	ltG/dkG	B/dkG		ltG/bG	g/b	g/b	
S Odor	NO	NO	NO		YES	NO	NO		NO	NO	NO		YES	YES	YES	
ssociated Debris																
Oil																
Coal													X			
Seeds										X				X	X	
Metals																
Glass		X														
Brick																
Blue Clay										X X	X X					

257

Density of Worm Tubes, Elliott Bay
Sampled 2,3,5 February 1976

		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MR3	2.0	4.0	4.0	3.33	12.0		14.0	8.67					6.0	9.0	2.0	5.67
	MR7			4.0	1.33	20.0			6.67		32.0	4.0	12.0	20.0			6.67
	MR8										4.0		1.33				
	MR9	24.0	4.0		9.33			12.0	4.00						8.0	8.0	5.33
	MR13	8.0			2.67												
	MR14															16.0	5.33
Sand Tubes	SF5										4.0		1.33				
	SF9	12.0		1.0	4.33		4.0		1.33	6.0		9.0	5.00		12.0		4.00
	SR1	48.0			16.00	4.0	4.0		2.67		16.0	12.0	9.33			4.0	1.33
	SR3										24.0		8.00				
	SR4		25.0	3.0	9.33			14.0	4.67	2.0		6.0	2.67	2.0	30.0	40.0	24.00
	SR5			1.0	0.33										2.0	4.0	2.00
	SR7	3.0	330.0	144.0	159.00	132.0		80.0	70.67	16.0	16.0	20.0	17.33	1.0	56.0	12.0	23.00
	SR10	16.0	8.0		8.00	8.0		12.0	6.67			8.0	2.67			4.0	1.33
	SR14						4.0		1.33	4.0	4.0		2.67				
	SC1	20.0	12.0		10.67	98.0	20.0	72.0	63.33	36.0	60.0	200.0	98.67	32.0	44.0	21.0	32.33
	SC6			4.0	1.33												
Mucous Membrane Tubes	MM3					4.0			1.33								
	MM5					12.0			4.00							1.0	0.33
	CA2		4.0		1.33							12.0	4.00				

Density of Wrom Tubes, Elliott Bay
Sampled, 2,3,5 February 1976

		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF6		4.0		1.33							4.0	1.33	12.0			4.00
	MF7						4.0		1.33								
	MR3	8.0		4.0	4.00	9.0	1.0	1.0	3.67	4.0		5.0	3.00	16.0	14.0	4.0	11.33
	MR9			20.0	6.67					12.0			4.00	16.0	4.0		6.67
Sand Tubes	SF9							17.0	5.67			12.0	4.00		4.0		1.33
	SR1	4.0	8.0	44.0	18.67					32.0	8.0	56.0	32.00				
	SR3		4.0		1.33									4.0			1.33
	SR4	20.0	4.0	25.0	16.33	16.0	4.0	10.0	10.00			6.0	2.00		8.0		2.67
	SR5						8.0	12.0	6.67								
	SR7		48.0	90.0	46.00	4.0	12.0	34.0	16.67	5.0			1.67	100.0	64.0	72.0	78.67
	SR10		12.0		4.00							4.0	1.33		8.0		2.67
	SR14									4.0		4.0	2.67				
	SC1	12.0	64.0	12.0	29.33	28.0	28.0	44.0	33.33	141.0	56.0	48.0	81.67	52.0	48.0	52.0	50.67
	SC2									5.0			1.67			4.0	1.33
	CA2		8.0		2.67												

Density of Worm Tubes, Elliott Bay
Sampled 2,3,5 February 1976

		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF6						4.0		1.33								
	MF7														4.0		1.33
	MR3					2.0			0.67	8.0	12.0	1.0	7.00		5.0		1.67
	MR7			4.0	1.33		16.0		5.33					20.0			6.67
	MR9										4.0	4.0	2.67		8.0		2.67
	MR14											4.0	1.33				
Sand Tubes	SF9		4.0		1.33			4.0	1.33					1.0	5.0	1.0	2.33
	SR1	56.0	16.0	24.0	32.00		8.0	4.0	4.00		4.0	4.0	2.67		3.0		2.67
	SR4					12.0	10.0	24.0	15.33			31.0	10.33		8.0	4.0	4.00
	SR5	4.0			1.33			4.0	1.33		4.0	5.0	3.00				
	SR7			4.0	1.33	24.0	14.0		12.67	44.0		24.0	22.67	8.0	59.0	40.0	35.67
	SR10	8.0	4.0		4.00			4.0	1.33	4.0		4.0	2.67				
	SR13						4.0	4.0	2.67								
	SR14										4.0		1.33				
	SC1	12.0	28.0	60.0	33.33	20.0	108.0	20.0	49.33	20.0	132.0	8.0	53.33	68.0	104.0	124.0	98.67 x
	SC2						4.0		1.33								
Mucous Membrane Tubes	MM1		4.0		1.33			4.0	1.33								
	CA12					4.0	12.0		5.33								

Density of Worm Tubes, Elliott Bay
Sampled 2,3,5 February 1976

		Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mud Tubes	MF1											8.0	2.67				
	MF6		8.0	4.0	4.00			8.0	2.67						8.0	20.0	9.33
	MR3	12.0			4.00	4.0	4.0	7.0	5.00			4.0	1.33	8.0		8.0	5.33
	MR7					4.0	24.0		9.33	8.0			2.67	16.0		4.0	6.67
	MR9					4.0	4.0		2.67					4.0	4.0		2.67
Sand Tubes	SF5					4.0			1.33					4.0	8.0	8.0	6.67
	SF9									4.0			1.33				
	SR1		20.0	4.0	8.00		100.0	40.0	46.67	16.0	4.0		6.67				
	SR3		4.0		1.33			1.0	0.33					4.0			1.33
	SR4	4.0			1.33		4.0	7.0	3.67	12.0		8.0	6.67			1.0	0.33
	SR5						1.0		0.33								
	SR7					8.0	56.0	16.0	26.67	28.0	20.0		16.00	32.0	12.0	20.0	21.33
	SR10		4.0		1.33	4.0	[illegible]2.0	4.0	20.00	12.0	4.0		5.33				
	SR14										4.0		1.33				
	SC1	56.0	24.0	32.0	37.33	64.0	160.00	120.0	114.67	28.0	104.0	8.0	46.67	60.0	24.0	36.0	40.00
Mucous Membrane Tubes	PC1									4.0			1.33				
	PC2					8.0			2.67								
	CA2					4.0		12.0	5.33								

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Harman, Robert A

Aquatic disposal field investigations, Duwamish Waterway disposal site, Puget Sound, Washington; Appendix F: Recolonization of benthic macrofauna over a deep-water disposal site / by Robert A. Harman, John C. Serwold, Shoreline Community College, Seattle, Washington. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.

171, [286] p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-77-24, Appendix F)

Prepared for Office, Chief of Engineers, U. S. Army, Washington, D. C., under Interagency Agreement WESRS 76-90 (DMRP Work Unit No. 1A10B)

Literature cited: p. 161-171.

1. Aquatic environment. 2. Benthic fauna. 3. Dredged material. 4. Duwamish Waterway. 5. Elliott Bay. 6. Field investigations. 7. Sampling. 8. Waste disposal sites. I. Serwold, John C., joint author. II. Shoreline Community College, Seattle, Wash. III. United States. Army. Corps of Engineers. IV. United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-77-24, Appendix F.

TA7.W34 no.D-77-24 Appendix F

Density of Worm Tubes, Elliott Bay
Sampled 2,3,5 February 1976

		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MR3					3.0	16.0		6.33					8.0	16.0		8.00
	MR7					20.0	8.0		9.33	4.0			1.33				
Sand Tubes	SF9														4.0		1.33
	SR1	16.0	120.0	160.0	98.67	15.0		20.0	11.67								
	SR3			1.0	0.33												
	SR4		4.0	1.0	1.67	13.0		28.0	13.67	16.0	4.0	8.0	9.33	28.0		4.0	10.67
	SR5	4.0	8.0	20.0	10.67	3.0			1.00								
	SR7		60.0	132.0	64.00	60.0		16.0	25.33		28.0		9.33		16.0		5.33
	SR10	4.0	72.0	64.0	46.67												
	SR13					1.0	12.0		4.33								
	SR14		16.0		5.33												
	SC1	48.0	44.0	44.0	45.33	26.0	8.0	12.0	15.33	32.0	4.0	16.0	17.33	48.0	52.0	32.0	28.00
	SC2										4.0	12.0	5.33	4.0	12.0		5.33
	SR2						4.0		1.33								
Mucous Membrane Tubes	MM1															4.0	1.33

otter trawls had seasonal low catches of fish during the winter compared to the high catches in spring and, especially summer months. At West Point and Alki Point the highest species richness occurred at intermediate depths (47 m) which also corresponds with the high species richness of the macrofauna. Stomach analyses of primarily juvenile fish in shallow subtidal habitats indicate their preference for small crustaceans such as Harpacticoid copepods, amphipods, and tanadaceans (Miller et al. 1975).

Habitats and Communities of Elliott Bay and Vicinity

Types and distribution

64. Table 3 and Figure 10 and 11 summarizes qualitatively the major subtidal benthic communities and associated habitats found within central Puget Sound. The major factor governing community structure in Elliott Bay and vicinity is whether the degree of water turbulence is sufficient to cause dispersal or retention of mud, wood and other particulate organic debris. The dispersal sites are typically found in wave or tidally scoured nearshore habitats and channels. In these dispersal habitats, amphipods and suspension feeding organisms characterize the community makeup. In contrast, retention sites are typically found in protected embayments, deltas formed by tidal eddies, forset beds of river deltas, sea bottoms where null zones occur between incoming and outgoing estuarine currents, or in entrapment areas caused by estuarian circulation (Figure 10). Organisms found in retention sites are deposit feeders typically represented by small clams or tube-dwelling polychaetes. These retention sites appear to be greatly influenced by the relative sedimentation rate or presence or absence of wood or coarse particulate organic debris. Four of these subtidal Puget Sound communities correspond to those identified by Lie and Kelly (1970) using R-mode multi-variant analysis. These groups were in part characterized by the following pelecypods: group I, *Psephidia lordi*; group III, *Ascila castrensis*; group IV, *Macoma carlottensis* and *Axinopsida serricata*; and group VI, *Nemocardium centifilosum* and *Nuculana minuta*. The remaining

Table 3

Subtidal Communities of Central Puget Sound

SHALLOW-SAND-GRAVEL D-1*
Amphipods-Pinnixia
Glycemeris-Protothaeca-Saxidomus-Pododesma
Barnacles-Sponges-Tunicates
Pisaster brevispinus-Sea cucumbers
Gastropod rich-Crepidula-Cerastostoma
Terebellidae-Ampharetidae-attached worm tubes
Trichohyalias-Glabratella-Elphidium crispum

SHALLOW - SAND D-3
Amphipods-Ostracods
Psephidia lordi
Macoma secta-Clinocardium
Sea Pens
Platynereis bicanaliculata
Elphidium selseyensis

SHALLOW-SAND-BRACKISH D-4
Amphipods
Upobegia pugettensis
Macoma inconspicua-Cryptomya
Scopolus-Eteone longa
Miliammina fusca

SHALLOW-MUD-BRACKISH-H_2S high sed R-1**
Upogebia pugettensis
Harpacticoid copepods-amphipods
Mya arenaria-Cryptomya-Macoma inconspicua
Abarenicola pacifica - Oligochaetes
Ammonium beccarii-Miliammina fusca
Trochammina inflata

SHALLOW-MUD-BRACKISH-WOOD-H_2S high sed R-2
Capitella capitata-Polydora-Cirratulus cirratus
Nereis procera-Lumbrineris luti-Tharyx sp.
Trochammina inflata-Miliammina fusca

SHALLOW-MUD-BRACKISH-WOOD-H_2S high sed. R-3
Ostracods-Amphipods
Macoma nasuta-Mysella tumida
Armandia brevis-Glycinde picta
Terebellides stroemi-Lumbrineris luti
Elphidium selseyensis

SHALLOW SAND-GRAVEL D-2
Amphipods
Protothaeca-Modiolus-Mysella tumida
Dendraster
Evasterias
Nassarius mendicus-gastropod rich
Trochammina pacifica-Elphidiella hannai-E. selseyense
Spiochaetopterus

INTERMEDIATE-SHALLOW-MUD-SAND low sed. R-4
Ascila castrensis-Compsomyax-pectins
Tunicates-sponges
Eupentacta-Cucumaria-brittle stars
Nassarius mendicus
Discammina-Elphidiella hannai-Bucella frigida

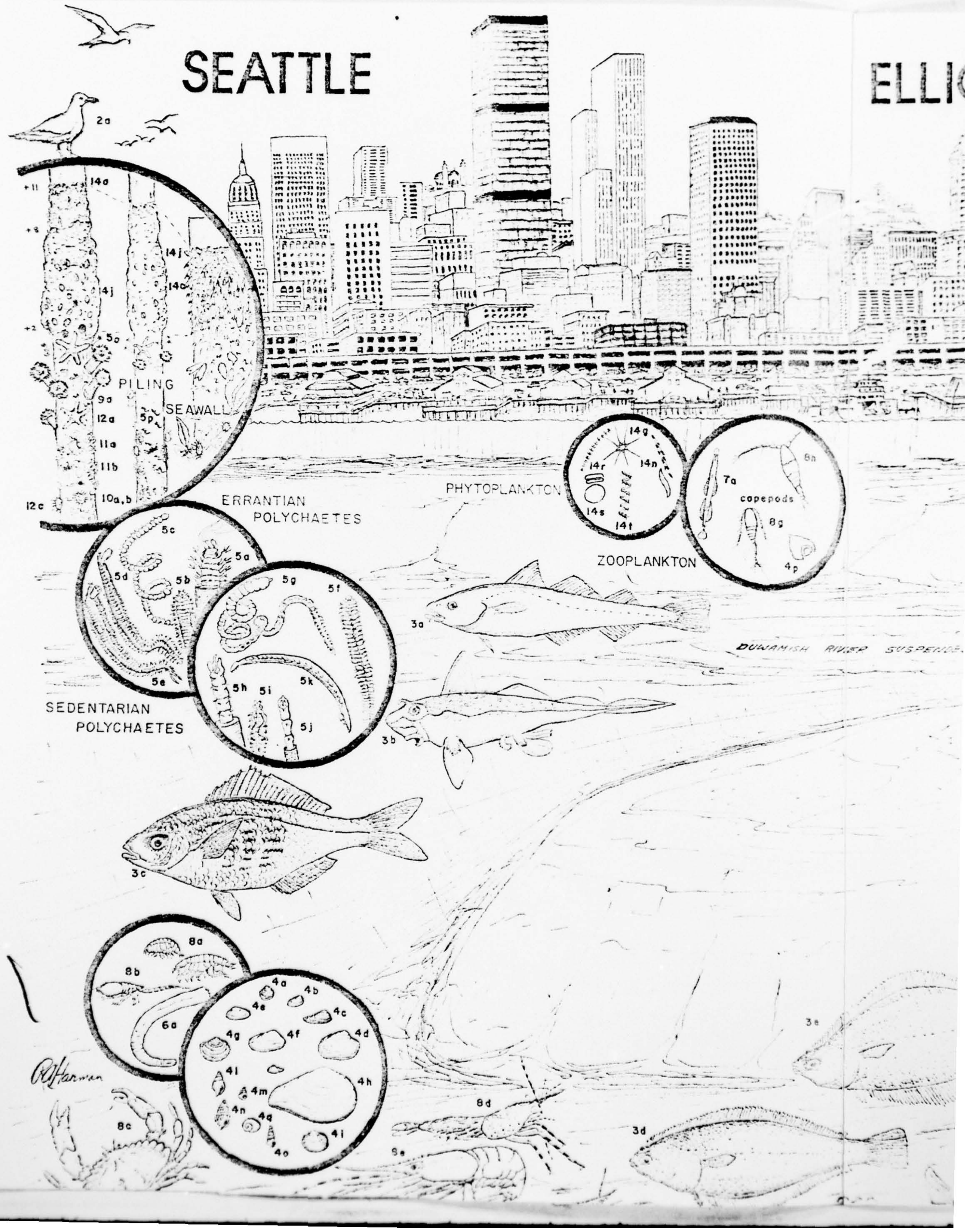
INTERMEDIATE-SAND D-5
Astarte sp.-Chaetozone setosa
Trochammina carlottensis-T. inflata

INTERMEDIATE DEPTH-SAND-GRAVEL-MUD D-6
Nemocardium centifilosa-Nuculata minuta
Pectins-Megacrenella-Bittium subplanatum
Sponges-tunicates
Mediaster aequalis
Phyllochaetopteris-Terebellids-Ampharetidaes
SR1-SR10-PC1,2
Eggerella advena-Leganimma atlantica

INTERMEDIATE-MUD-WOOD-H_2S high sed R-5
Ammotrypane aulogaster-Polydora
Glycera capitata-Nephtys ferruginea
Lumbrineris luti-Heteromastus filobranchus-Euclymene zonalis
Onuphis iridescens-Laonice cirrata-Pectinarians
Gastropod poor-Mitrella-Axinopsida-Macoma carlottensis
Discammina-Reophax-Recurvoides

DEEP-MUD low sed R-6
Cumaceans
Macoma carlottensis-Yoldia scissurata
Glycera capitata
Pectinarians-Praxilella affinis-Asychis similis-Ampharetidae
Briaster townsendi-Molpodia intermedia-MR3,7,15-SC1,2

*Dispersal
**[illegible]ention


SEATTLE
ELLI
PILING
SEAWALL
ERRANTIAN
POLYCHAETES
SEDENTARIAN
POLYCHAETES
PHYTOPLANKTON
ZOOPLANKTON
copepods
DUWAMISH RIVER SUSPENDE
2a
14a
14j
5a
9a
12a
5p
11a
11b
10a, b
12c
5c
5d
5b
5e
5g
5f
5h
5i
5j
5k
14g
14r
14n
14s
14t
7a
8n
8g
4p
3a
3b
3c
3d
3e
8a
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6a
4a
4b
4c
4d
4e
4f
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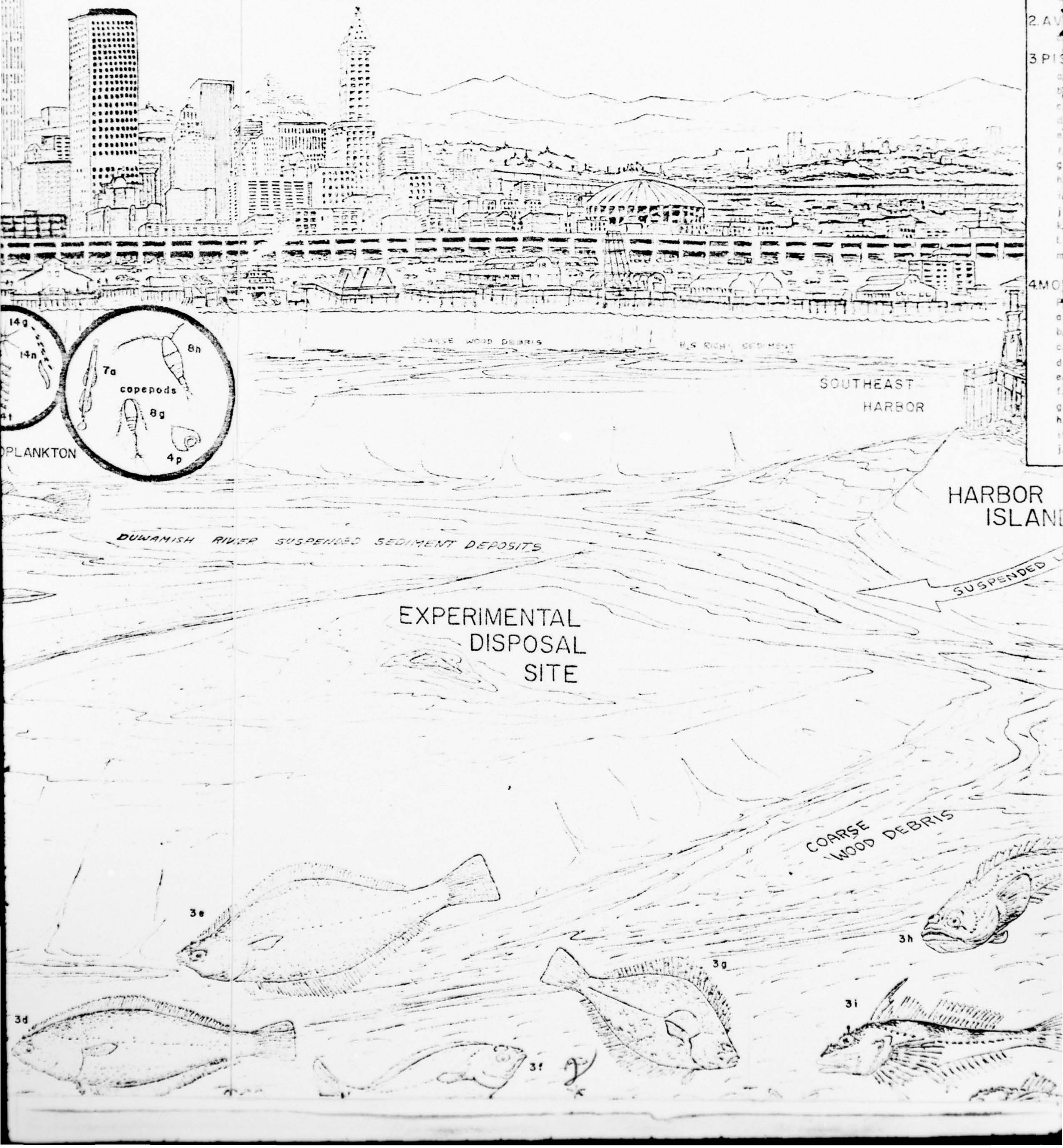
R.J. Harman

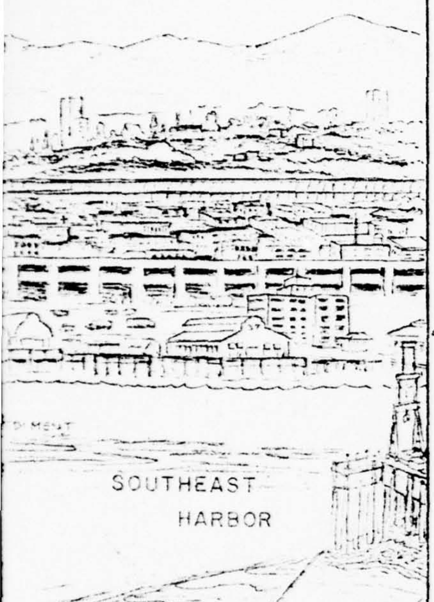
ELLIOTT BAY

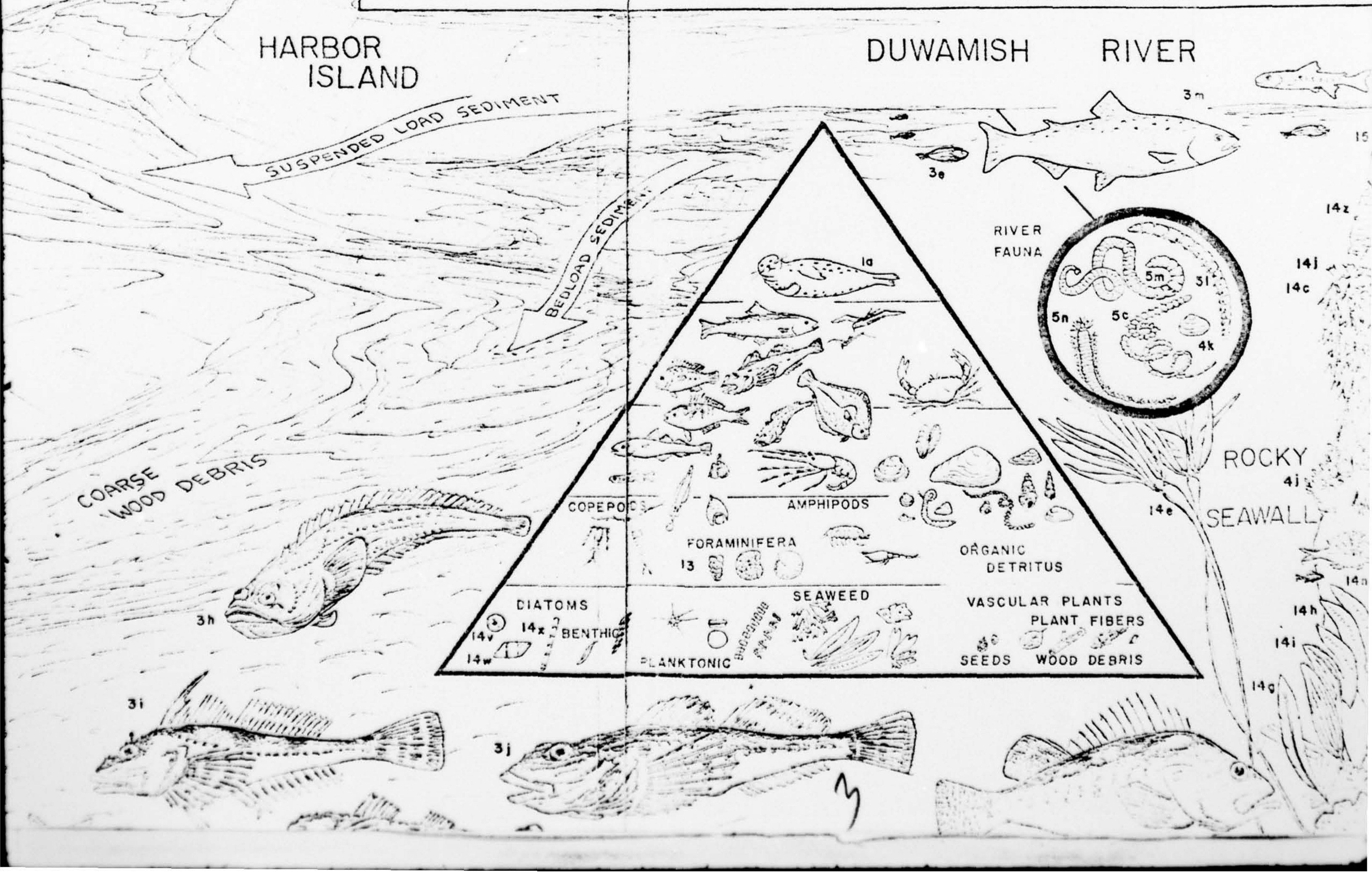


1. MA
2. AV
3. PIS
4. MO
14g
14n
7a
8h
copepods
8g
4p
PLANKTON
COARSE WOOD DEBRIS
SOUTHEAST
HARBOR
HARBOR
ISLAN
DUWAMISH RIVER SUSPENDED SEDIMENT DEPOSITS
SUSPENDED
EXPERIMENTAL
DISPOSAL
SITE
COARSE
WOOD DEBRIS
3e
3h
3g
3d
3i
3f

CHARACTERISTIC FLORA AND FAUNA

1. MAMMALIA
   a. Harbor Seals
2. AVES
   a. Sea gulls
3. PISCES
   a. Pacific Tomcod
   b. Ratfish
   c. Shiner Perch
   d. Dover Sole
   e. English Sole
   f. Flathead Sole
   g. Rock Sole
   h. Midshipman
   i. Roughback Sculpin
   j. Pacific Staghorn Sculpin
   k. Sturgeon Poacher
   l. Copper Rockfish
   m. Silver Salmon
4. MOLLUSCA
   PELECYPODA
   a. Axinopsida serricata
   b. Nucula tenuis
   c. Nuculana minuta
   d. Compsomyax subdiaphana
   e. Macoma carlottensis
   f. Macoma alaskana
   g. Lucinoma annulata
   h. Macoma nasuta
   i. Nemocardium centifilosum
   j. Mytilus edulis
   k. Macoma inconspicua
   GASTROPODA
   l. Mitrella gouldi
   m. Barlea sp
   n. Nassarius mendicus
   o. Bittium subplanatum
   p. Pteropods
   q. Natica clausa-Polinices
   r. Thais lamellosa
5. ANNELIDA
   POLYCHAETES
   a. Onuphis iridescens
   b. Nephtys ferruginea
   c. Lumbrinereis luti
   d. Glycinde picta
   e. Glycera capitata
   f. Laonice cirrata
   g. Heteromastus filobranchus
   h. Praxilella gracilis
   i. Polydora uncata
   j. Euclymene zonalis
   k. Ammotrypane aulogaster
   l. Abarenicola pacifica
   m. Capitella capitata
   n. Nereis procera
   o. Eudistylia vancouveri
   p. Serpula vermicularis
6. NEMERTEA
   a. Cerebratula sp
7. CHAETOGNATHA
   a. Sagitta sp
8. CRUSTACEA
   a. Amphipods
   b. Cumaceans
   c. Cancer productus
   d. Pandalus danae
   e. Pandalus borealis
   f. Pandalus platyceros
   g. Oithona similis
   h. Acartia longiremis
   i. Pugettia productus
   j. Hemigrapsus nudus
   k. Balanus glandula
   l. Balanus cariosus
9. CNIDARIA
   a. Metridium senile
   b. Tealia crassicornis
   c. Anthopleura elegantissima
10. PORIFERA
    a. Haliclona sp
    b. Halichondria sp
11. TUNICATA
    a. Styela gibbesii
    b. Corella willmeriana
12. ECHINODERMATA
    a. Evasterias troschelii
    b. Mediaster aequalis
    c. Strongylocentrotus drobachiensis
    d. Parastichopus californicus
    e. Cucumaria miniata
    f. Psolus chitonoides
13. FORAMINIFERA
14. AL
15. LI





CHARACTERISTIC FLORA AND FAUNA

Figure 9.

MAMMALIA
- a. Harbor Seals

AVES
- a. Sea gulls

PISCES
- a. Pacific Tomcod
- b. Ratfish
- c. Shiner Perch
- d. Dover Sole
- e. English Sole
- f. Flathead Sole
- g. Rock Sole
- h. Midshipman
- i. Roughback Sculpin
- j. Pacific Staghorn Sculpin
- k. Sturgeon Poacher
- l. Copper Rockfish
- m. Silver Salmon

MOLLUSCA

PELECYPODA
- a. Axinopsida serricata
- b. Nucula tenuis
- c. Nuculana minuta
- d. Compsomyax subdiaphana
- e. Macoma carlottensis
- f. Macoma alaskana
- g. Lucinoma annulata
- h. Macoma nasuta
- i. Nemocardium centifilosum
- j. Mytilus edulis
- k. Macoma inconspicua

GASTROPODA
- l. Mitrella gouldi
- m. Barlea sp
- n. Nassarius mendicus
- o. Bittium subplanatum
- p. Pteropods
- q. Natica clausa-Polinices
- r. Thais lamellosa

5. ANNELIDA

POLYCHAETES
- a. Onuphis iridescens
- b. Nephtys ferruginea
- c. Lumbrinereis luti
- d. Glycinde picta
- e. Glycera capitata
- f. Laonice cirrata
- g. Heteromastus filobranchus
- h. Praxilella gracilis
- i. Polydora uncata
- j. Euclymene zonalis
- k. Ammotrypane aulogaster
- l. Abarenicola pacifica
- m. Capitella capitata
- n. Nereis procera
- o. Eudistylia vancouveri
- p. Serpula vermicularis

6. NEMERTEA
- a. Cerebratula sp

7. CHAETOGNATHA
- a. Sagitta sp

8. CRUSTACEA
- a. Amphipods
- b. Cumaceans
- c. Cancer productus
- d. Pandalus danae
- e. Pandalus borealis
- f. Pandalus platyceros
- g. Oithona similis
- h. Acartia longiremis
- i. Pugettia productus
- j Hemigrapsus nudus
- k. Balanus glandula
- l. Balanus cariosus

9. CNIDARIA
- a. Metridium senile
- b. Tealia crassicornis
- c. Anthopleura elegantissima

10. PORIFERA
- a. Haliclona sp
- b. Halichondria sp

11. TUNICATA
- a. Styela gibbesii
- b. Corella willmeriana

12. ECHINODERMATA
- a. Evasterias troschelii
- b. Mediaster aequalis
- c. Strongylocentrotus drobachiensis
- d. Parastichopus californicus
- e. Cucumaria miniata
- f. Psolus chitonoides

13. FORAMINIFERA

14. ALGAE

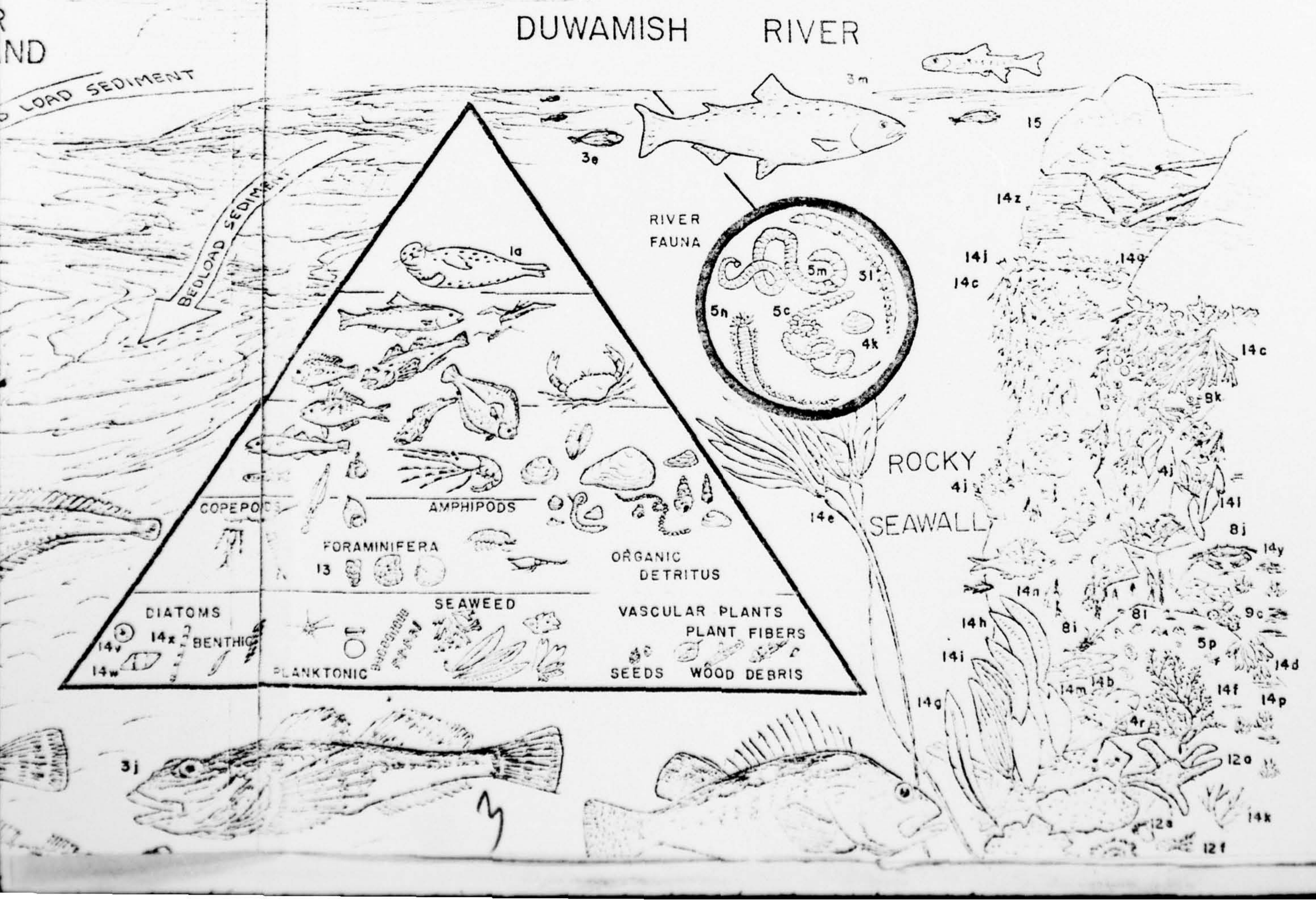
CHLOROPHYCEAE (GREEN)
- a. Enteromorpha intestinalis
- b. Ulva sp

PHAEOPHYCEAE (BROWN)
- c. Fucus gardneri
- d. Fucus distichus
- e. Nereocystis luetkeana
- f. Sargassum muticum
- g. Alaria marginatum
- h. Laminaria saccharina
- i. Costaria costata

RHODOPHYCEAE (RED)
- j. Gigartina cristata
- k. Agardhiella tenera
- l. Porphyra perforata
- m. Iridaea cordata
- n. Microcladia sp
- o. Gigartina exasperata
- p. Odonthalia floccosa

BACILLARIOPHYCEAE (DIATOMS)
- q. Asterionella sp
- r. Thalassiosira sp
- s. Conscinodiscus sp
- t. Chaetoceros sp
- u. Nitzschia sp
- v. Asterotychus sp
- w. Isthmia-Biddulphia sp
- x. Milosiranae sp
- y. Navicula sp
- z. CYANOPHYCEAE (BLUE-GREEN)

15. LICHENS



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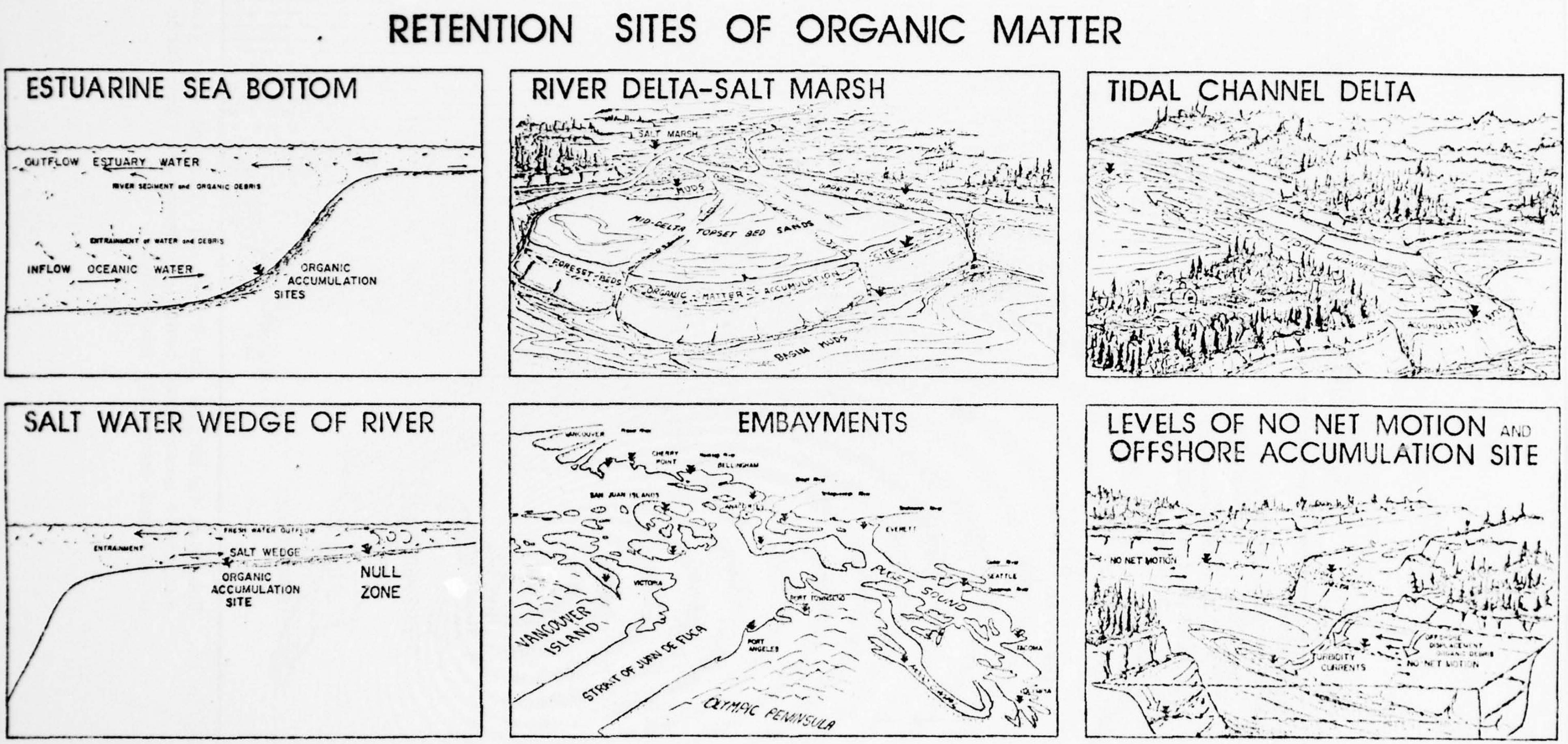

Figure 10. Typical retention sites (arrow) of fine sediment and organic matter in Puget Sound. Unless polluted most of the retention sites have high concentrations of macrofaunal organisms and high numbers of species.

SUBTIDAL COMMUNITIES CENTRAL PUGET SOUND

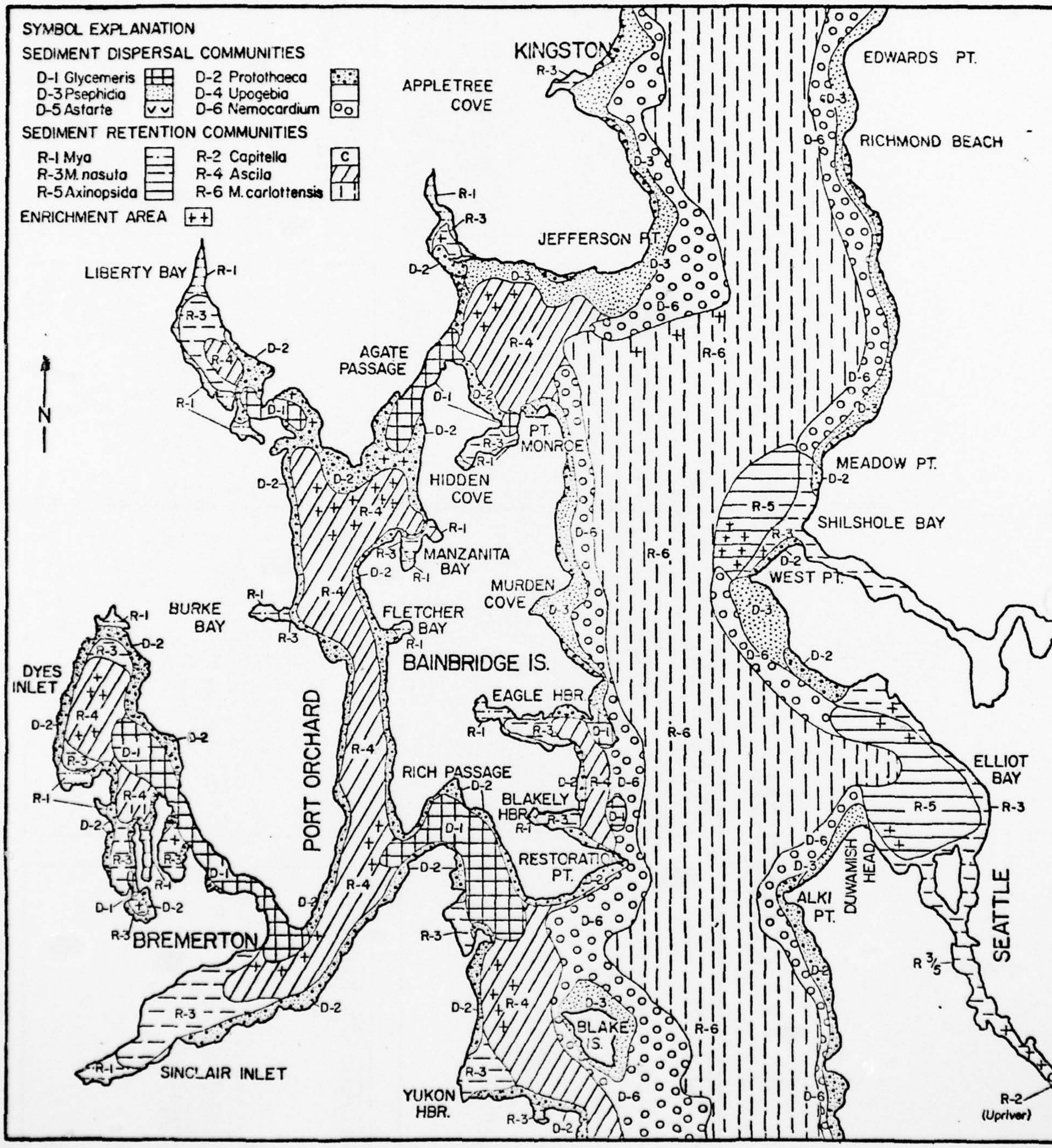

Figure 11. Subtidal retention and dispersal sites of fine grain sized sediment and their associated benthic community. See Table 3 for explanation of typical community occupants.

groups II and V are faunas found off the coast of Washington. Equivalent retention and dispersal communities as used by this report (Table 4) are D-3 (gr I) R-4 (gr III) R5,6 (gr IV) D-6 (gr VI) respectively.

Elliott Bay Communities

65. In the intermediate depths of Elliott Bay incorporating the experimental disposal site, Lumbrineris luti, Heteromastus filobranchus and maldanid populations occur along with small deposit-feeding clams such as Axinopsida serricata and Macoma carlottensis. (R-5, Table 4). Foraminifera are those typically found in organic enriched sites such as Reophax scorpiurus, Legenammina atlantica and Discammina plannissima. In the shallower protected habitats of Elliott Bay the H_2S rich muds contain the polychaetes Glycinde picta, Armandia brevis, and Prionospio malmgreni as well as abundant small and large deposit-feeding clams, Psephidia lordi, and Macoma nasuta, respectively (R-3).

66. In the wave and tidal current scoured sands outside Elliott Bay are found numerous amphipods, tanadaceans, ostracods along with Psephidia lordi, and a tube-dwelling polychaete Platynereis bicanaliculata (D-3). Directly below this shallow habitat organic debris accumulates in muddy sands and gravels and is dominated by Nemocardium centifilosum and Nunculana minuta as well as more frequent occurrences of suspension feeding ampharetids, terebellids, and chaetopterid polychaetes (D-6). In the deep basin areas of central Puget Sound green diatom-rich muds occur containing the predatory polychaete Glycera capitata and the large tube dwelling deposit feeder Pectinaria californiensis (R-6). In this deep, muddy habitat the major biomass contributor is that of the heart urchin Brisaster latifrons and the holothuroid Molpadia intermedia.

67. Distinctly reduced in density in the habitats of Elliott Bay are gastropods, which dominate the more distant estuaries of Dyes Inlet, Sinclair Inlet, and Liberty Bay. Absent from the study area is the community having abundant specimens of Ascila castrensis typical of Port Madison and Port Orchard, muddy areas more distant from wood accumulation sites (R-4). Another missing community is Astarte spp. (D-5), typical of the current swept-coarse sands on ridges between Camano and Gedney Islands, near Port Susan.

Duwamish River channel communities

68. Changes in the sediment characteristics, relative frequency of species, and densities of both the microbiogenic components of sediment and macrofauna occur along the channel length of the Duwamish River (Figures 12, 13, 14). Marine faunas dominate areas north of 1st Avenue Bridge while the more brackish water or euryhaline species dominate areas to the south.

69. A marked reduction in the densities and number of species of marine and brackish water organisms occur in the turn basin south of slip 6 associated with coarse sand with little mud. These coarse sand deposits are typical of the sand found in the river delta topset beds and river channels of the Snohomish River where occasional large specimens of amphipods and rare foraminifera or diatoms occur. The transition area between these topset beds and the deeper dredged river channel muds is an area of abundant wood and fiberous plant debris mixed with sands and muds. This wood-plant accumulation zone represents the present day "foreset beds"; formally these foreset beds were located on the northerly seaward side of Harbor Island. In these wood debris bed samples large amphipods occur with occasional polychaete specimens of Abarenicola pacifica. Seaward of the forset beds between slip 6 and 14th Avenue bridge is an area of opportunistic polychaete species, Capitella capitata and Nereis procera and further seaward Polydora uncata. It is from this zone that dredging occurred during this study. These polychaetes along with oligochaetes and the pelecypod Macoma inconsiqua characterize the shallow marginal areas of the Duwamish River channel*.

70. Between the 14th Avenue bridge and the 1st Avenue bridge the highest densities of polychaetes consist primarily of Lumbrineris luti and Cirratulus cirratus. North of the 1st Avenue bridge marine species are more typical of the Elliott Bay community, consisting of such polychaetes as Lumbrineris luti and Heteromastus filobranchus, pelecypods Axinopsida serricata and Psephidia lordi, foraminifera Eggerella advena, Legenammina atlantica, and Reophax scorpiourus, and high concentrations of centric diatoms Concino discus. South of the 1st Avenue Bridge

*Personal Communication, September 1977, Henry Leon, Natural Resource Planner, Pacific Rim Planners, Inc., Seattle, WA.

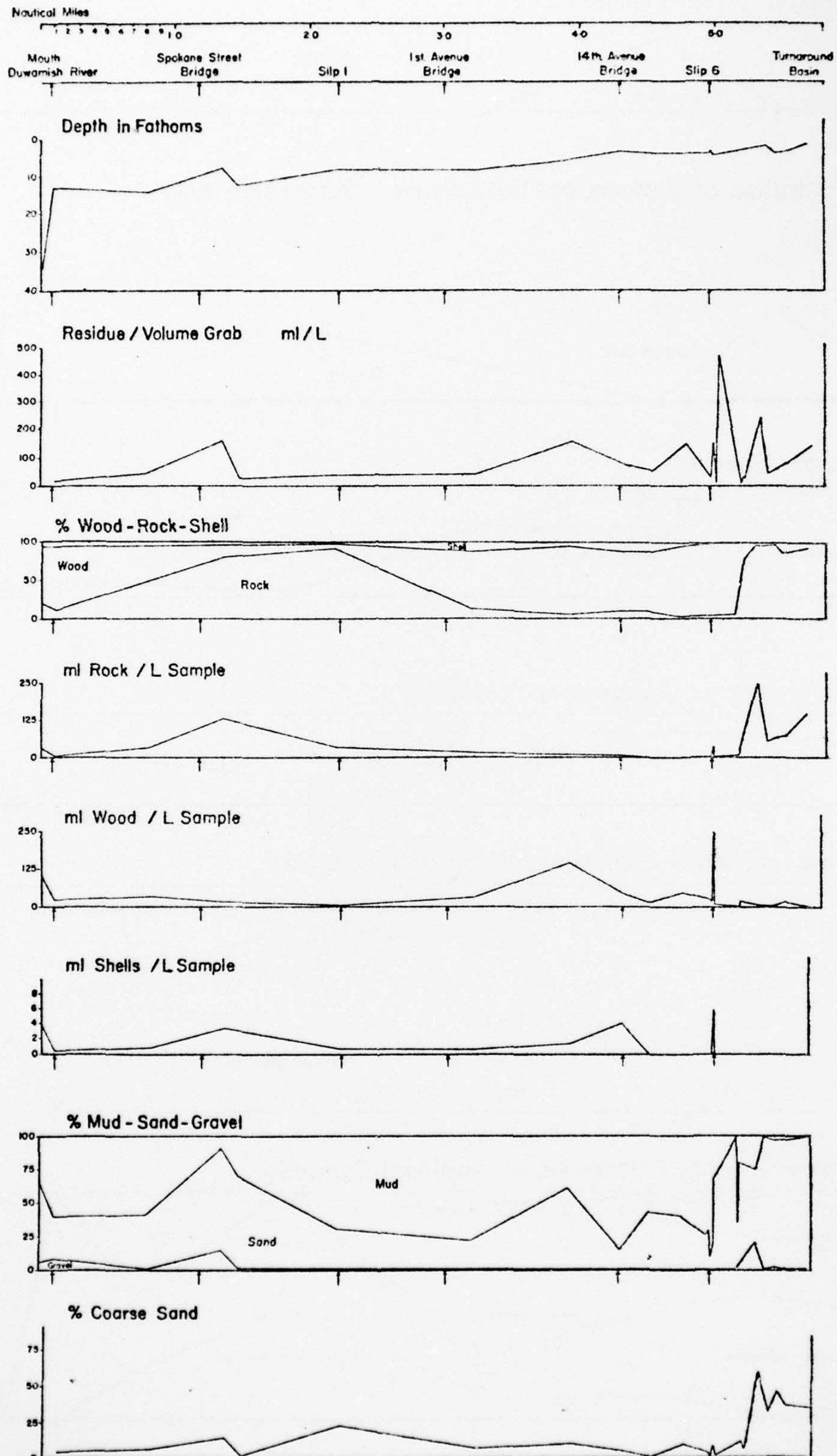

Figure 12. Depth and sediment changes occurring from off the mouth of the Duwamish River to uppermost portion of the dredged river channel (turnaround basin). Disposal material was obtained between slip 6 and 14th Avenue bridge.

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AQUATIC DISPOSAL FIELD INVESTIGATIONS, DUWAMISH WATERWAY DISPOS--ETC(U)
JUN 78 R A HARMAN, J C SERWOLD WESRS-76-90
UNCLASSIFIED WES-TR-D-77-24-APP-F NL

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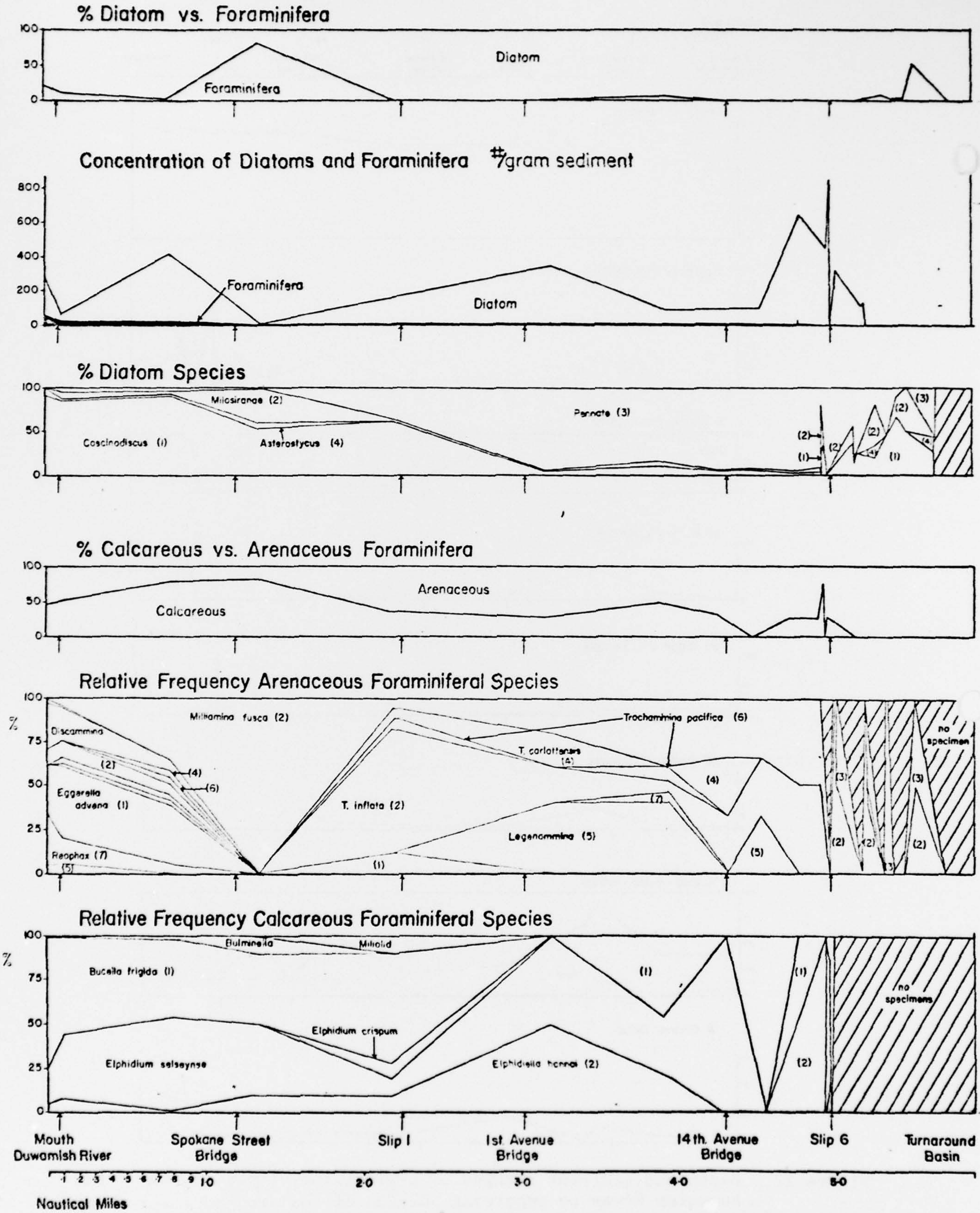


Figure 13. Changes in diatom and foraminiferal components along the length of the Duwamish River channel. Brackish water faunas increase towards turn-around basin.

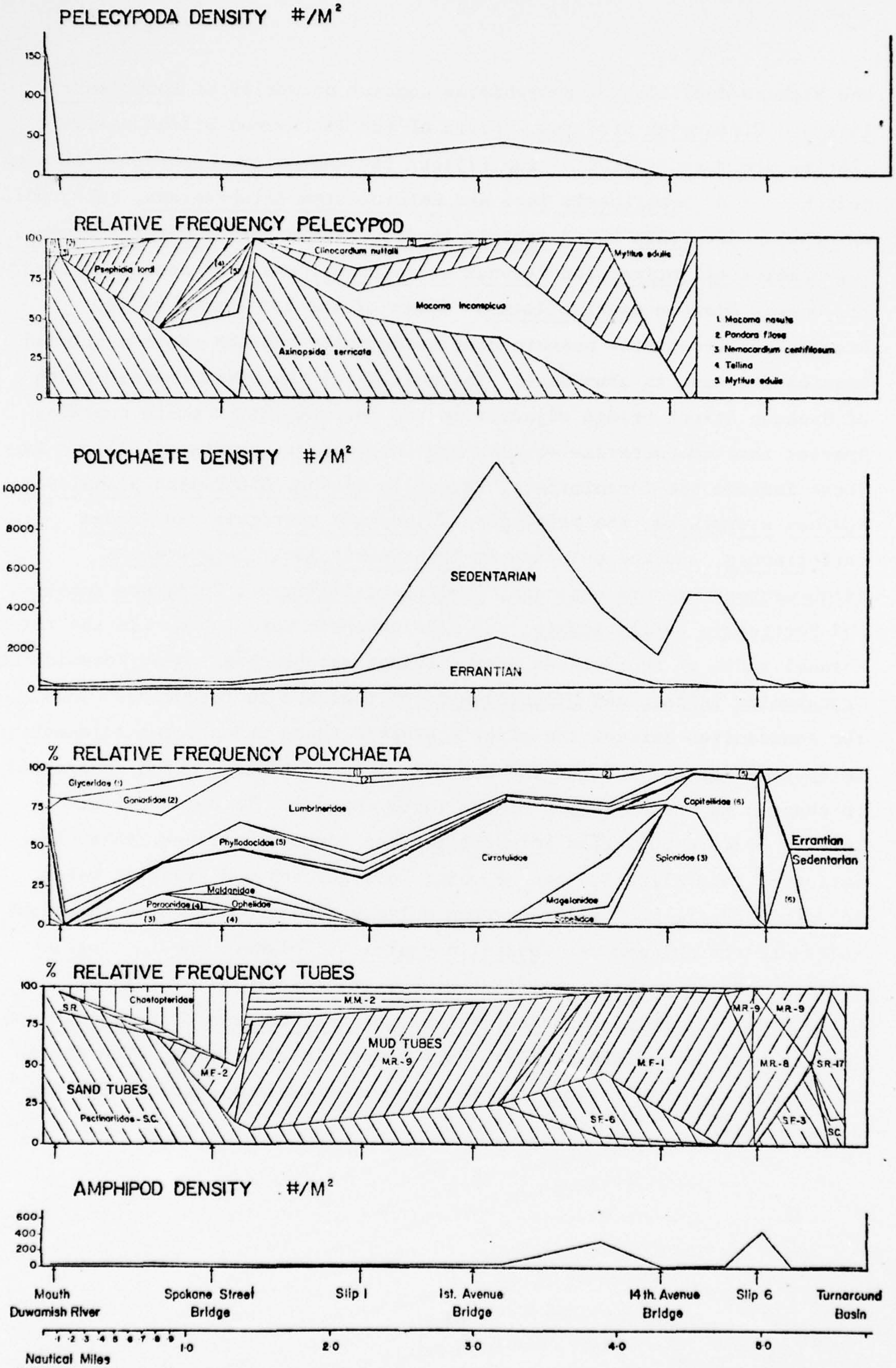


Figure 14. Changes in pelecypods, polychaetes, and amphipods along the length of the Duwamish River channel.

the highest densities of polychaetes consist primarily of Lumbrineris luti and Cirratulus cirratus. North of the 1st Avenue bridge marine species are more typical of the Elliott Bay community, consisting of such polychaetes as Lumbrineris luti and Heteromastus filobranchus, pelecypods, Axinopsida serricata and Psephidia lordi, foraminifera Eggerella advena, Legenammina atlantica, and Reophax scorpiourus, and high concentrations of centric diatoms Concinodiscus. South of the 1st Avenue bridge brackish or freshwater pennate diatoms dominate and the above-mentioned species decrease in abundance. The portion of the river channel north of Spokane Street bridge adjacent to the Duwamish River mouth contains species that characterize shallow and intermediate depths of Elliott Bay. These include the foraminifera, Eggerella advena, Discammina plannissima, Reophax scorpiurus, the pelecypods Axinopsida serricata and Macoma carlottensis, and the polychaetes Lumbrineris luti Heteromastus filobranchus, Glycera capitata, Phyllodoce williamsi, Euclymene zonalis, and Pectinaria califoriensis, and more abundant worm tubes. In the river channel south of the Spokane Street Bridge the brackish water foraminifera Trocahmmina inflata and Miliammina fusca increase in frequency. Thus, the boundanries between the river's benthic fauna zones occur adjacent to Spokane Street, and the 1st and 14th Avenue bridges, which correspond to changes in the direction of the river channel. If opportunistic species or more pollution tolerant species increase upriver, then the following generalization can be made: polychaetes and brackish water foraminifera are more tolerant than molluscs, gastropods being the least tolerant; the polychaetes Capitella capitata, Polydora uncata, Nereis procera and Abarenicola pacifica are more tolerant, followed by Cirratulus cirratuls, Lumbrineris luti and Heteromastus filobranchus and last by most large tube dwellers such as pectinarian worms. The degree of tolerance should reflect the sequence of organisms recolonizing the disposal site.

PART III: METHOD OF STUDY

Project Phases and Station Locations

71. The project consisted of five phases; the pilot study (phase 1), predisposal sampling (phase 2), dredging and disposal (phase 3), postdisposal (phase 4), and data analysis and report preparation (phase 5). In the pilot study (phase I) 80 samples within the southern portion of Elliott Bay were collected and analyzed during November and December 1975, primarily at depths adjacent ot the 68 m contour (Figure A 1). The 80 samples were collected using a VanVeen .1m^2 grab sampler and included five stations (stations 3, 17, 21, 25, and 44) having 5 replicate samples in order to assess the variability between stations. The experimental disposal site and the east and west reference site were selected on the results of the pilot study which also included the analysis of demersal fish as well as the physical and chemical nature of the bottom sediment.

72. The disposal site located off Harbor Island near the mouth of the Duwamish River waterway (Figure 2) consists of a 4 by 4 sampling grid with the 16 stations spaced on 91.4 meter (300 feet) centers. Both east and west reference site were included to best assess the seasonal changes of river sedimentation or other factors associated with east-west difference within the bay.

73. During phase 2, or prior to disposal, 48 samples were collected over the disposal grid site, 12 samples from the four east and west stations, and 20 samples from the 20 river stations (Figure 2). The river station samples were collected between the 14th Avenue bridge and slip 6. Dredging and disposal (phase 3) occurred over a 40-day period from 17 February to 6 March 1976. A total of 1.17 miles (1.88 km) of the uppermost Duwamish River channel (river mile 3.90 to 5.07) was dredged using a clam shell dredge. The total volume of dredge material disposed at the site was 149,427 cu yd (114,250m^3). Bottom open-door barges were used with a 380 to 535 m^3 capacity that represented 49 separate individual barge load dumpings over the disposal site. Post disposal sampling (phase 4) occurred only at the disposal site and the reference site at 10 day (17, 18, March), one month (15 April),

3 months (15 June), 6 months (15 September) and 9 months (8, 9 December) after disposal and dredging (6 March).

Field Methods

74. Stations were located using a Del Norte positioning system. A box corer was unsuccessfully used during phase 2. Adequate sediment samples from the corer were difficult to obtain due to the presence of large pieces of wood and rock debris. All samples in this study were collected for each sampling period using an 0.1 m^2 VanVeen grab sampler. Grab sampler penetration depths of 5, 10, 15, and 20 cm would have equiiivant grab volumes of 2.6, 6.7, 11.5 and 17.7 l, respectively. Grab samples were described as to nature of sediments, thickness of the surface sediment, layer, color, odor, and volume of sample collected. Samples were then washed using filter seawater through a screen with 1 mm openings in order to separate the macrofauna from the mud and fine sand. The remaining residue on the screen was stored in 1 ℓ jars in a 10 percent buffered formalin solution.

75. The collection of demersal fish species for stomach analysis was made by NMFS using a semiballoon otter trawl. Fish from each trawl were separated and stored in plastic bags containing 10 percent formalin. During phase 2 many species were collected, while during phase 4 fish collected were primarily dover sole, english sole and flathead sole. Difficulties in collecting sufficient numbers of representative fish made comparisons between sampling periods statistically impossible.

Laboratory Methods

76. The amount of wash residue stored in the 1-ℓ jars was determined in the laboratory. A semiquantitative measurement of the amount of wood, rock, and shell debris was made by visually estimating their separate percentages. These percentages were then multiplied by residue volume (ml) and divided by the grab volume (ℓ) in order to obtain concentrations

of rock, wood, and plant fibers. An attempt was made to visually separate wood debris from plant fibrous material and leaf debris. "Rock" percentage estimates were inclusive of both mineral and rock debris. Despite this relatively crude estimate, the method has been excellent in defining the areal extent of river-influenced habitats and tidal or wave-scoured sea bottoms of Puget Sound.

77. The stored, washed residues were then picked for their macrofauna constituents and sorted into three groups; the Mollusca, other macrofaunal organisms, and empty worm tubes. Sorted samples were stored in a glycerin-ethanol preservative. Wet weights were made using a Mettler balance after specimens were first blotted for excess moisture. Fish specimens were measured as to standard length and weight and stomach contents were removed and preserved in vials containing glycerin and ethanol. Polychaete identifications were made using the published (Errantian) and unpublished (Sedentarian) keys of Banse and Hobson (1975).

Data Presentation and Analysis

78. Charts included in this report depict the areal and temporal distribution of sediment and organisms and follow the older classical approach to benthos ecology where each species or group of species are considered separate entities in terms of their concentration. Modern benthos approaches using diversity indices or statistical measures will be included in a summary report of the Duwamish Waterway, Puget Sound to be prepared by WES. Geometric contour intervals were used when depicting concentrations of sediment debris and density of organisms, or where emphasing small or large values in order to best illustrate distribution trends. The contour intervals chosen were considerate of the regional concentration values of central Puget Sound so that high values (solid color and lines) or low values (dashes, dots and circles) can be readily compared and contrasted. In this report use of the words uniform and significant does not imply similar statistical connotations.

PART IV: RESULTS*

Identification of Opportunistic Species, Annuals and Climax Species

79. The major goal of this entire study was to assess the spatial and temporal changes in the benthic macrofauna over the experimental disposal site. Before discussing in detail the evidence for these changes, it might be best to indicate the strategy used in discerning the disposal impact on the life and rate of succession as well as identify the various types of recolonizers that make up the communities. Figure 15 and 16 illustrate graphically how changes in concentration are utilized in this study to identify dredged material disposal affected and unaffected species. Species whose concentrations decline or increase due to disposal impact are affected species in contrast to unaffected species whose concentrations do not change immediately after the disposal. Three categories of affected species include:

- a. Opportunistic species. Species that were rare or absent prior to disposal that increased markedly in concentration after disposal.

- b. Annuals. Species that were present or common before disposal that showed marked increases or decreases in concentration during the year.

- c. Climax species. Those species that were present or common before disposal that showed marked decline in concentrations after disposal and no marked seasonal increases or decreases in concentrations at the reference stations.

80. Further discussion and subdivisions of affected species are described below. Grassle and Grassle, 1974 and McCall, 1977 review the characteristics of opportunistic species as those having (a) initial response to disturbed conditions, (b) ability to increase rapidly, (c) large population size, (d) early maturation and (e) high mortality. In this study, identification of opportunistic species was principally based on species having low concentrations prior to disposal and subsequent marked increases in concentration in areas influenced by dredged material disposal. Opportunistic species at their preferred habitats should show marked seasoanl high and low concentrations. As indicated in Figure 15

*The results of phase I on selection criteria for reference and disposal sites are discussed in Appendix A.

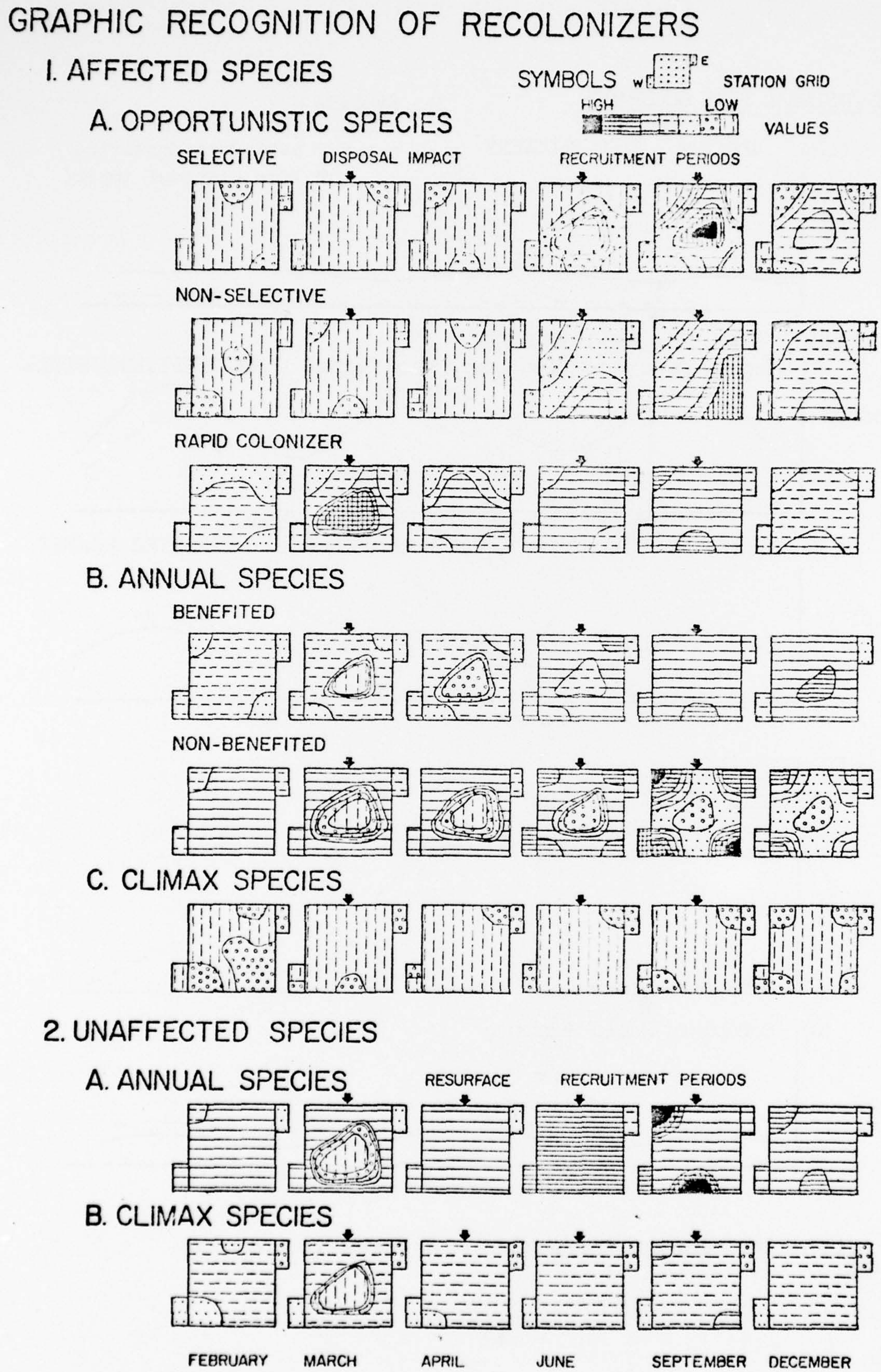


Figure 15. Classification scheme of recolonizers and graphic method of recognizing each type based on temporal and spatial changes in their sea bottom concentrations.

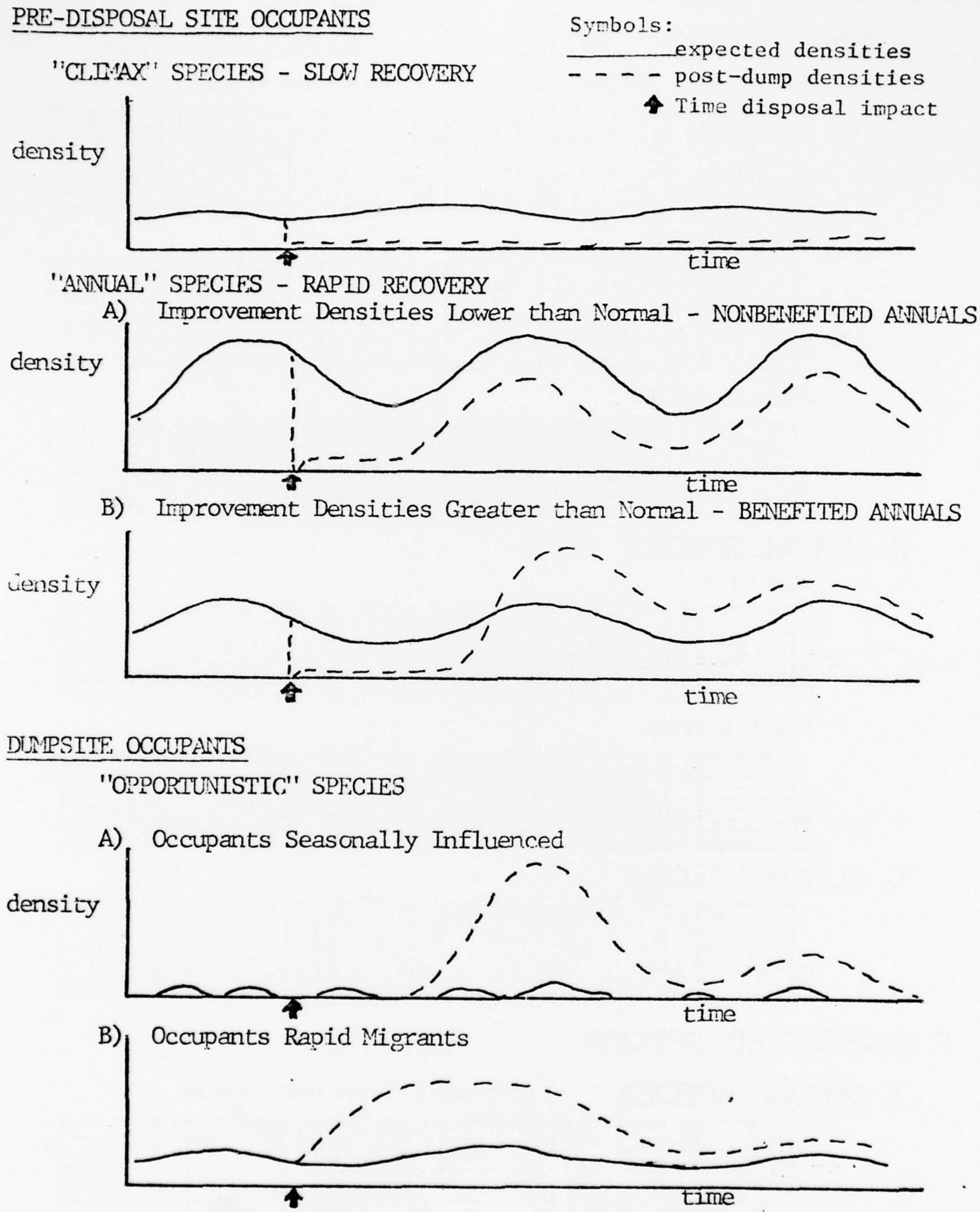


Figure 16. Graphic recognition of types of recolonizers.

three types of opportunistic species were identified:

a. Selective opportunistic species. These species showed marked increases mainly over areas where complete burial of the community occurred, the impact site. *Polydora uncata* and *Ammotrypane aulogaster* exemplified this group (Table 4).

b. Nonselective opportunistic species. These species showed marked increases over the entire area influenced by the disposal. Examples include: *Amphicties scaphobranchiata Aricidea longicornuta*, *Trochochaeta multisetosa* and *Eteone longa*.

c. Motile opportunistic species. These rapid colonizer species are the immediate colonizers of the disposal area regardless of time of recruitment.

81. No macrofauna organisms from the grab sample study were detected that showed immediate recolonization over the disposal site. The immediate presence of shrimp and fish over the disposal site may typify this group of unseasonally controlled recolonizers of unexploited habitats. However, if concentrations do not exceed former levels than these species would be considered unaffected annuals.

82. Annuals, like the selective and nonselective opportunists recruit their numbers each year and subsequently show marked seasonal fluctuations in their numbers or biomass in contrast to the climax species (Figure 15 and 16). The distinction between opportunistic species and annulas is that the annuals were normal occupants of the community prior to disposal. Benefited annuals show improvement over both direct impact sites and disposal influenced areas. In contrast nonbenefited annuals show slow recovery over the direct impact site but may or may not increase in concentration in the marginal areas influenced by the dredged material. In this study it appears that in the marginally influenced areas nonbenefited annuals were benefited by filling niches left by the removal of climax species. Examples of benefited annuals are motile predator worms such as: *Glycera capitata*, *Nephtys ferruginea*, *Glycinde armigera* the deposit feeder, *Prionospio malmgreni*; and possibly the clam *Macoma moesta alaskana*. Examples of nonbenefited annuals are deposit-feeding polychaetes

Table 4

Classification of Stress Tolerant or Inhibited Species
and
Relationship to Opportunistic Species, Annuals and Climax Species

Opportunistic Species (First to Recolonize)	Benefited Annuals	Nonbenefited Annuals	Climax Species (Last to Recolonize)
STRESS TOLERANT			STRESS INHIBITED
Polychaetes			
Capitella capitata	Glycinde picta	Euclymene zonalis	Praxilella gracilis
Polydora ligni	G. armigera	Heteromastus filobranchus	P. affinis
P. uncata	Glycera capitata	Lumbrineris luti	Asychys similis
Ammotrypane aulogaster	Nephtys ferruginea	Terebellids stroemi	Onuphis iridescens
Nereis procera	Phyllodoce williamsi	Spionophanes bombyx	Pectinaria californiensis
Amphicteis scaphobranchiata	Prionospio sterstrupi		Chaetozone setosa
Eteone longa			most ampharetids, terebellids,
Aricidea longicornuta			sabellids
Trichochaeta multisetosa		Sand Tube SR-7,8	Mud Tube MR-3,7,15
Cirratulus cirratus		Chaetopterian tubes	Pectinarian Tubes
Abarenicola pacifica			Rigid Sand Tubes SR-1,10,4
Pelecypods			
Macoma inconspicua	Macoma moesta alaskana	Axinopsida serricata	Nemocardium centifilosum
Mya arenaria	Psephidia lordi	Macoma carlottensis	Nuculana minuta
	Macoma nasuta	Nucula tenuis	Megacrenella columbiana
	Mysella tumida	Compsomyax subdiaphana	Clinocardium nuttalli
		Saxidomus gigantea	Macoma secta
		Protothaca staminea	Glycemeris subsoluta
Gastropods		Barleeia sp.	Trichotropis cancellata
		Mitrella gouldi	Ceratostoma foliatum
			Thais lamellosa
			Nassarius mendicus
Foraminifers			
Trochammina inflata	Elphidium selseyensis	Buccella frigida	Elphidium crispum
Millimamina fusca	Buliminella elegantissima	Elphidiella hannai	Trichohyalis columbiana
	Reophax scorpiurus	Eggerella advena	Glabratella ornatissima
	Discammina planissima	Legenammina atlantica	Trochammina charlottensis
			Cibicide lobatus
			Rosalina columbiana
			Planktonic foraminifera

Heteromastus filobranchus and Euclymene zonalis; the clams Axinopsida serricata, Macoma carlottensis, Nucula tenuis, and Lumbrineris luti; and amphipods.

83. Although the term climax species is utilized frequently in succession studies on land, little attention has been focused on disposal studies on the nature of community occupants that require long periods of time to recover or establish themsleves in a community. However, much attention has been given to communities that have achieved a high degree of biological interaction such as those found in the tropics or deep ocean basins. As discussed in the literature review (Part 1) several writers proposed, notably Sanders 1968, that these (climax) species would be most sensitive to physical changes that occur in their habitats. Most of these species are considered to have long life spans, slow growth rates, and small brood sizes (Grassle and Sanders, 1973). Many are normally large size, epibenthic, suspension feeders or occupy large tubes. Recognition of these climax species at the impacted disposal site would show little recovery or no seasonal change in their numbers or biomass at the reference sites. In this study many of the organisms that preferred habitats outside Elliott Bay (or were found in areas of different substrate characteristic and showed no recovery) were considered expatriated climax species in contrast to normal occupants or in situ climax species. In this study, examples of the in situ climax species were Pectinaria californiensis, Praxilella gracilis, Laonice cirrata and Onuphis iridescens. The empty rigid sand tubes SR-1 and 10; molluscs Nemocardium centifilosum Nuculana minuta and Mitrella gouldi and to a lesser extent Barleeia sp. are considered expatraited climax species (Table 4).

84. McCall, 1977, utilizes the term equilibrium species as opposed to climax species to indicate species found during the final adjustment phase recovering defaunated substrates. He characterizes equilibrium species as those having few reproductions per year, low recruitment, slow development, late colonizers, and low mortality rates. These equilibrium species he describes from Long Island Sound are large, mobile and have no brood protection or those having planktotrophic larvae. The

authors prefer the term climax species since opportunistic species, benefited annuals, nonbenefited annuals or climax species can dominate when at equlibrium with variously stressed habitats. Thus, removal of stress conditions from a community dominated by opportunistic species would cause succession with communities dominated first by benefited annuals, then by unbenefited annuals and finally by climax species. However, succession may stop if sufficient stress is applied to the community.

Expected responses

85. In the discussion of the results an attempt will be made to classify the occupants over the disposal site as to type of recolonist and to indicate the relative degree of disposal impact on their distribution Three areas will be discussed: (a) a direct impact area where organisms were completely buried or eliminated by disposal material, (b) an adjacent area where dredged material was deposited but not sufficient for complete suffocation of all normal occupants, and (c) an unaffected area outside of the disposal area (in this study the reference stations). The authors believe that the removal of climax species causes subsequent increases in both annuals and opportunistic species. In the area of direct impact, selective opportunistic and rapid reoccupants (or motile opportunists) occupy the site with subsequent latter increases in benefited annuals. Outside the impact area, where lesser amounts of dredged material accumulated, selective opportunistic species were fewer in number and benefited annuals and nonbenefited annuals dominated. It is believed that the reduction in climax species over both sites made possible the relative increases in opportunistic species, benefited annuals and non-benefited annuals. However, it should be emphasized that recolonization is a function of the relative degree of replacement of niches caused by the reduction in impacted species.

86. Consideration should also be given to the mechamism of recolonization for each group; opportunistic species are considered those having many reproductions per year, rapid development, thus recruitment over defaunated seabeds is more likely possible. In populated, partially impacted habitats the remaining oraganisms may prevent the establishment

of opportunistic species through predation of their larvae. Annuals, which are normally smaller in size and have relatively large brood sizes, may increase in areas where climax species have been reduced. Thus, opportunistic species and annuals are generally easier repopulated through larvae recruitment. In contrast, climax species have low larval concentrations, small brood sizes, and slow growth rates and are not easily replaced through larval recruitment; but, because of their large size they may have a greater chance to resurface after burial. However, these species did not regain their predisposal concentrations suggesting a poor survival rate. In this study the relatively short sampling period prior to disposal and the absence of in situ larvae recruitment experiments such as those of Oliver et al. 1976 made assessing of the relative roles these factors may have on controlling larval settlement and subsequent recruitment difficult.

Duwamish River Sediment and Macrofauna

87. The material disposed in Elliott Bay was dredged from the upper portion of Duwamish River between slip 6 and the 14th Avenue bridge. The 20 samples collected had low rock contents in the residues. Both wood and plant fiber contents increased upriver from values less than 10 ml/ℓ to those exceeding 30 ml/ℓ. Samples contained equal amounts of rock and wood-plant fiber debris. Stations seaward of station 30 were consistently high in H_2S. Wood and plant fiber concentration were high over the experimental dumpsite compared to their river content, suggesting that the disposal site increased in concentration due to differential settlement of wood debris. The sediment in the river usually had a light brown layer over a dark-brown to black subsurface layer. Oil and tar were frequently found in these samples.

88. Most river samples were species poor and had low macrofauna densities. No gastropods or pelecypods were observed. The dominant worms found were Capitella capitata, Lumbrineris luti, and Nereis procera, the latter two species found in the samples seaward of station 37.

Significant was the absence of the worms Polydora uncata and Cirratulus cirratus and the small clam Psephidia lordi compared to their occurrence in samples collected in 1975. Also, worm concentrations and species richness were lower than those detected by this earlier unpublished regional study (Figure 14). This decline in concentration and reduction of species may have been due to: (a) previous dredging that occurred in 1975-1976, or (b) major flooding that occurred prior to the 1977 dredging.

Physical and Chemical Nature of Disposal Material and Impact

89. Between 16 February 1976 and 6 March 1976 approximately 114,250 m^3 of dredged material was discharged near the center of the disposal grid marked by a lighted buoy. The following description of the disposal release impact and the physical and chemical effects of dredged material is quoted from the DMRP information Exchange Bulletin (Vol D-76-4, August 1976). "Most of the material left the barge as clumps or as well-defined mass falling with a maximum velocity of 180 cm/sec. A dense surge of material flowed out from the impact point at a speed of approximately 36 cm/sec. The surge was greater than 6 m but less than 25 m thick and was detected more than 200 m from point of impact. The surge and the associated increase in suspended sediment became undectable within 10 min after disposal. A slight reduction in transmittance (10 percent) was found over the disposal mound 150 min after disposal within 25 m of the bottom...Dissolved oxygen concentrations in the lower two-thirds of the water column were reduced during almost all disposal operations; however, reductions never exceeded 9.9 mg/ℓ and were usually less than 0.5 mg/ℓ. Thirty minutes or less was usually required before dissolved oxygen concentrations returned to normal."

90. Preliminary analysis of the bathymetric survey data "indicates that the largest dredged material mounds (1.2 - 2.7 m) are located 61 to 83 m directly west of the anchored buoy...Smaller disposal mounds, ranging from 0.3 to 0.9 m, are scattered erratically over a 371,600-m^2 area but more commonly occur in the northwest and northeast quadrants of

the sampling grid." This benthic study (Shoreline) indicated maximum disposal impact over stations 7, 10, and 11 and minimal impact at the corner grid stations. Preliminary sediment chemistry data indicate that these direct impact stations also corresponded to elevated values of ammonium and PCB's.

Spatial and Temporal Changes in Field Description Data

Sampling depths

91. No significant differences in the sampling depth trends (Figure 17a) over the grid stations were observed; depths consistently increased from the southwest corner towards the northeast corner. Sampling depths show a range from 173 ft in the southwest corner of the disposal site to 222 ft in the northeast corner. The east reference site depths had a range from 154 to 178 ft at station 19 and 162 to 186 ft at station 20. West reference sites ranged from 170 to 208 ft at station 18 and 160 to 201 ft at station 17. The eastern reference site appeared to be consistently shallower than those at the experimental disposal site and west reference site. The drift of the vessel caused by both tide and wind may have caused differences in the within-station sampling depths of replicate samples. This variability at the replicate stations may have influenced the variability found in sediment and biological data.

Volume grab sample and field description of sediment

92. Prior to disposal, grab volumes increased with increasing depth of water (Figure 17b), a trend observed in central Puget Sound. After disposal, sampling volumes generally decreased over the central stations that were impacted by the disposal material except during the last sampling period. The average volumes ranged from 3.8 to 16 ℓ (approximately depth of penetration was 7 to 19 cm); most samples averaged greater than 8 ℓ (penetration greater than 12 cm).

93. In general, samples with greater wood and rock residues had lower volumes due to lesser penetration of grab through the coarse debris.

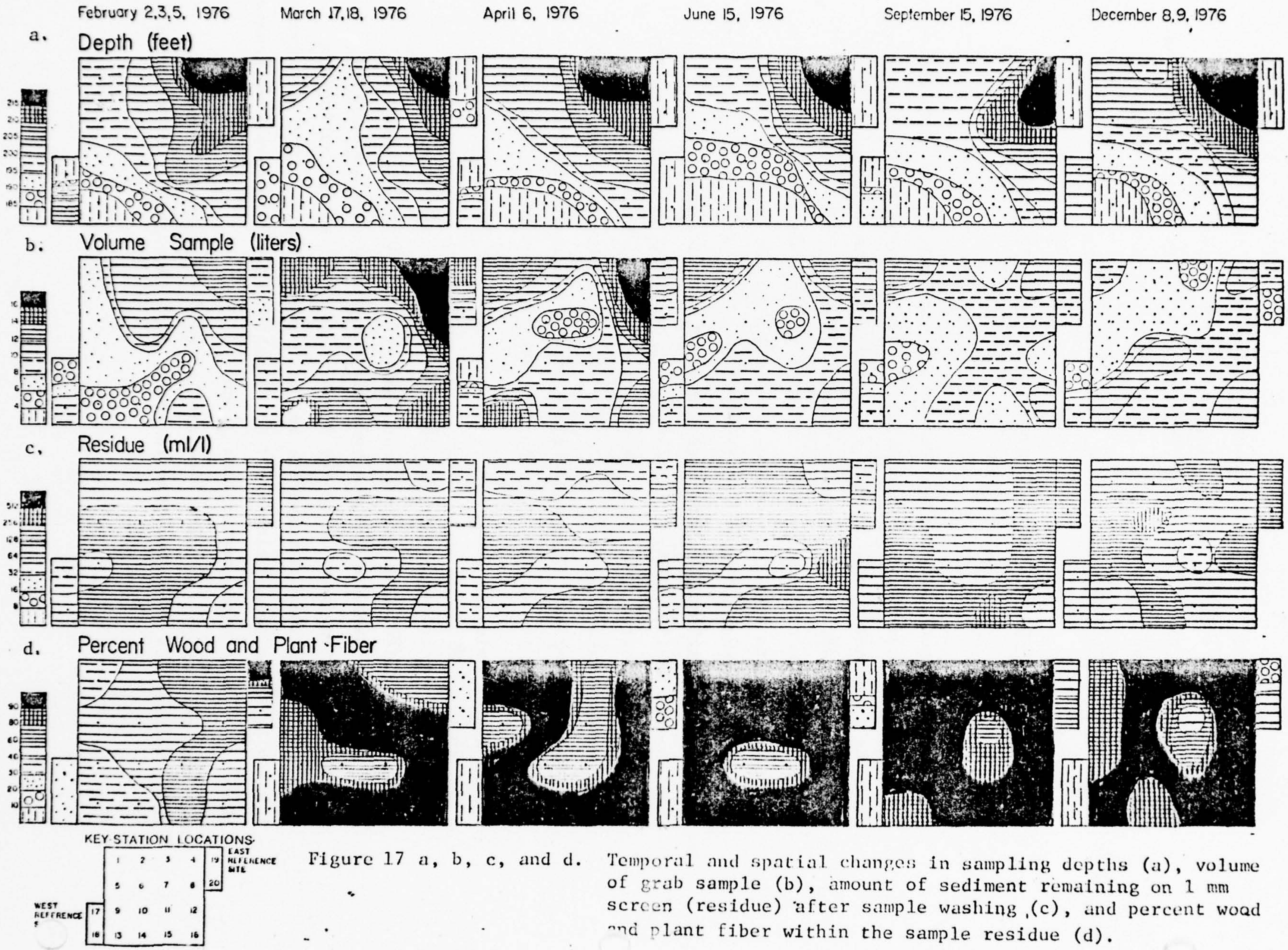


Figure 17 a, b, c, and d. Temporal and spatial changes in sampling depths (a), volume of grab sample (b), amount of sediment remaining on 1 mm screen (residue) after sample washing (c), and percent wood and plant fiber within the sample residue (d).

Prior to disposal the largest volumes were in samples consisting of fine mud normally found in the deeper northeastern portion of the sampling grid area or at the east reference site. The smallest grab volume consistently occurred at the west reference site, especially station 17 which had a high percent of sand. After disposal the largest volumes were most frequently collected at the corner stations (stations 1, 4, 13 and 16); the smaller volumes collected over the center stations were likely caused by the greater amounts of wood and rock debris and subsequent shallower penetration by the grab sampler.

94. Bottom sediment over the experimental disposal site prior to disposal consisted of a thin 1 to 3 cm) superficial brown or light-green layer over a dark greenish-gray colored sediment. Most of the sediment lying below the surface layer had some degree of black mottling coloration. Immediately after disposal most samples had little or no superficial layer, but when present over the impact site it consisted of a brownish rust-colored layer over very black sediment containing H_2S and increasing amounts of oil and tar. After 3 months, a superficial brownish layer 0.5 to 2 cm thick was present over the blackened sediment. Except for station 20, the reference site consisted mostly of light-green muds, muddy sand over dark-green mud, or muddy sands. Oil was found in many of the samples as well as other debris such as seeds, metals, plastic, and coal.

Washed sediment residue

95. The volume of sediment residue in post disposal samples was not significantly different from that found in predisposal samples although it was significantly changed in composition (Figure 17c). Most reference samples had residue volumes less than those from the experimental disposal site. Residue volumes generally ranged from 40 to 360 ml/ℓ, most containing approximately 128 ml/ℓ. The most striking change occurred in the percent wood and plant fiber debris relative to other residue materials (Figure 17d). Before disposal most of the disposal grid residue samples contained an equal amount of rock, plant, and wood debris. After disposal the percentages of wood and plant fiber increased to values greater than 95 percent except immediately over the impact area (Stations 10,

11, and 7). This marked change in residue composition indicated that the dredged material was dispersed beyond the margins of the grid system. The fact that no significant changes in residue composition occurred at the reference areas indicated their isolation from the dredged material influence. Although total residue volumes did not significantly change before and after disposal, residue materials had increased in percentages of wood plant debris with a lesser percentage of rock debris.

96. Rock residues (Figure 18a) showed a marked reduction with values ranging from 153 ml/ℓ in the shallow areas of the grid to 21.6 ml/ℓ at the deeper stations. After disposal, rock debris generally was less than 10 ml/ℓ and experienced a maximum reduction in June, which most likely corresponds to the relative increased dilution of fibrous plant material by bedload transport. In the area of direct impact of dredged material, station 11 had the highest values during the first 3 months, but later the highest values were at station 7. This change in the amount of rock debris after disposal may have been due to: (a) dilution of wood and fibrous material, (b) currents winnowing away wood material, or (c) variability in the data (most probable). Rock debris concentrations over the reference area showed no significant changes after disposal, their values being 2 to 3 times more concentrated than those at the disposal site after disposal.

97. After disposal both wood and fibrous plant debris increased (Figure 18b). Total concentration of wood and plant debris normally exceeded 64 ml/ℓ over most stations and had a maximum value of 316 ml/ℓ. These values are substantially higher than those determined from river samples from the dredged area. This increase in concentrations over the disposal site suggests possible differential settlement of the wood and fibrous debris. The marked increase of plant fiber over the entire disposal grid occurred in June suggesting a possible seasonal input of plant debris by bed-load transport (Figure 18c and d). This period of fibrous material deposition also corresponds with the seasonal increase of both pelecypod and worm concentrations suggesting that these organisms seek fibrous plant debris as refuge sites. The absence of

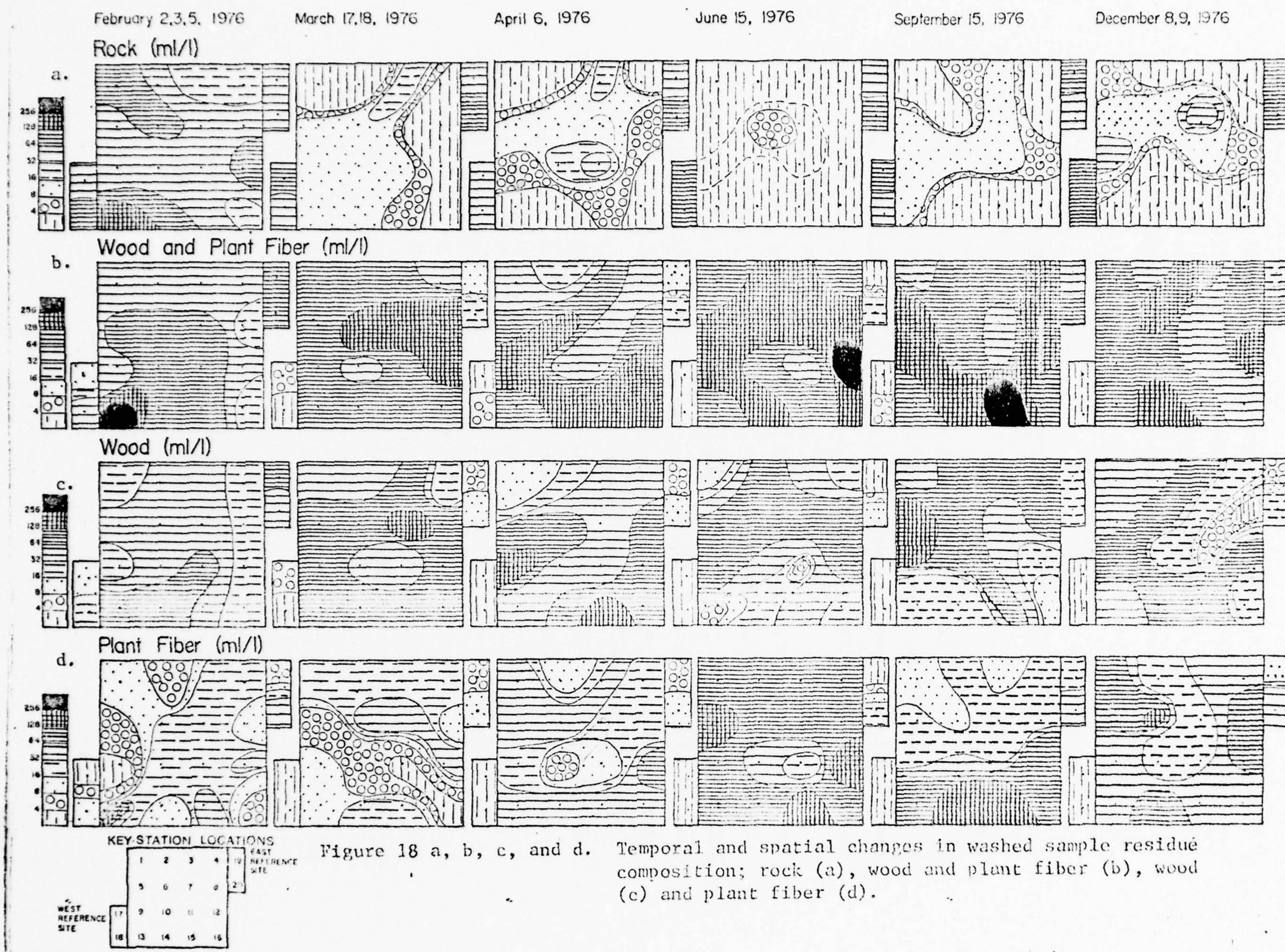


Figure 18 a, b, c, and d. Temporal and spatial changes in washed sample residue composition; rock (a), wood and plant fiber (b), wood (c) and plant fiber (d).

sediment trap studies makes the assessment of the realtive role of recruitment via water column or bed-load transport difficult. In addition, the lack of seasonal information on the compositional changes in bed-load and suspended load material within the Duwamish River channel adds to this difficulty.

Spatial and Temporal Changes in Molluscan Fauna

Density

98. Prior to disposal pelecypod concentrations were generally greater than 128 specimens/0.1 m^2 (Figure 19a). After disposal, reduction in concentration occurred over most of the disposal sites. Highest declines occurred over station 11 followed by stations 10, 7, 9, 12, 15, and 2; corner stations 1, 4, 13, and 16 were least impacted. The greatest rate of recovery occurred at the corner and side stations while those concentrations over the direct impact area showed very little improvement. Slight increases in concentration over the entire disposal site occurred during June and September followed by a slight overall decline in December at the central stations. Although a summer increase was indicated during the postdisposal sampling at both reference and disposal sites values did not show a significant seasonal increase over predisposal winter concentrations. Lie 1968 described a similar reduction between February predisposal time, and August, postdisposal, in the dominate species of this study, *Axinopsida serricata* and *Macoma carlottensis*. However, despite this decline, the relative dominance of these species did not change and, based on the size structure of *A. serricata*, a summer recruitment was indicated. The overall decline over the central stations in most pelecypods might be the result of the increased wood contents over the disposal site. Reduced densities of *A. serricata* is consistent with regional trends in Puget Sound which show the species to be markedly reduced in very high wood rich substrates (Harman et al. 1977b). Another possible explanation of this shell reduction in wood rich samples might be due to low pH production during

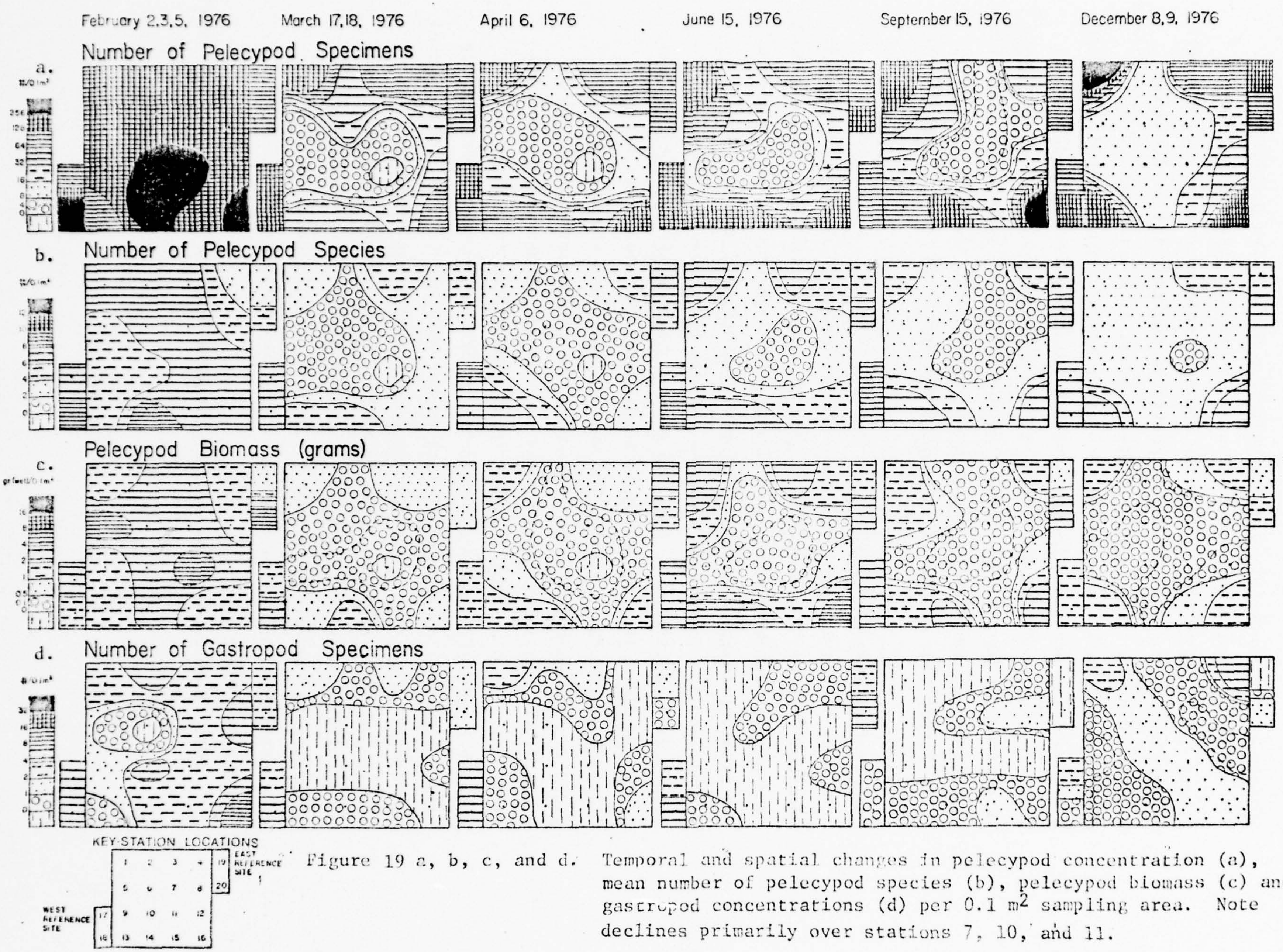


Figure 19 a, b, c, and d. Temporal and spatial changes in pelecypod concentration (a), mean number of pelecypod species (b), pelecypod biomass (c) and gastropod concentrations (d) per 0.1 m^2 sampling area. Note declines primarily over stations 7, 10, and 11.

storage at the laboratory despite additions of buffered preservatives.

99. *Axinopsida serricata* followed by *Macoma carlottensis*, *Nucula tenuis* and *Nuculana minuta* were the dominant pelecypod species. The rate of improvement for each of these species varied and will be discussed later. Pelecypod densities over the disposal site were high (1500 to 3000 specimens/m^2), in comparison to other areas of Puget Sound. Similar high densities occur at the mouth of the Columbia River in muddy sands that are also wood rich and have the same dominant species, *A. serricata* (Richardson et al. 1977). Similar high densities of pelecypods consisting of a different species *Psephidia lordi* was found on the wood-rich muddy delta forset beds of the Stillaguamish and Snohomish River (Harman et al. 1977b).

Number of pelecypod species

100. After disposal a decline in the number of species (Figure 19b) occurred over the entire disposal grid system. The greatest postdisposal rate of improvement occurred in June at the marginal or corner stations. The greatest impacted areas were found at stations 7 and 11. This overall decline in species richness was due to the poor recovery of *Nemocardium centifilosum*, *Nuculana minuta*, *Megacrenella columbiana*, and *Cardiomya oldroydi*. No seasonal changes were observed at either the disposal or reference sites. The western reference sites generally had a greater number of species compared to the eastern sites. Close proximity to shallower habitats may account for higher western species richness. The number of dominant species occurring in Elliott Bay is high when compared to the stress habitats of the Duwamish River of pulp mill influenced habitats of Everett Harbor and Port Gardner. The general absence of *A. serricata* and the low number of dominant pelecypod species reported at these sites by Malkoff 1976, Kisker 1976 and Harman et al. 1977b was significant. The greater number of dominant species occurring in Elliott Bay probably also reflects the numerous sources of expatriated fauna from nearshore and river habitats.

Pelecypod biomass

101. Like density and species richness biomass (wet weight) declined

over the impacted site upon disposal of dredged materials (Figure 19c). The greatest impact occurred again at stations 7, 10 and 11 respectively. During the sampling periods the corner stations showed the greatest rate of improvement, the maximum rate of increase occurring during the June sampling. Although Axinopsida serricata is small and has low biomass per individual, the decline of this species contributed significantly to the overall decline in total pelecypod biomass. During the December sampling, impacted areas showed some degree of improvement suggesting some recruitment. Western reference sites had higher biomass values primarily due to the greater frequency of large pelecypods such as Compsomyax subdiaphana, Nemocardium centifilosum, and Nuculana minuta.

102. Pelecypod biomass (wet weight) predisposal values were generally high, most values exceeding 1 g/0.1 m^2 with several stations having values greater than 2 g/0.1 m^2. Lie, 1968 documented shallow (23 m) and deep (195 m) water stations (1 and 2, respectively) in Shilshole Bay area having biomass values of 0.995 and 0.948 g/0.1 m^2, respectively. In estuaries adjacent to Everett (Harman et al. 1977b) deep basin values were generally less than 0.5 g/0.1 m^2, but values on the river deltas exceeded 1 g/0.1 m^2; forset bed values were consistently higher than 2 g/0.1 m^2.

Density of gastropods

103. Densities of gastropods in the study area were low in contrast to other areas of central Puget Sound although higher than those concentrations existing in the Duwamish River (Figure 19d). After disposal, decline in gastropod concentration occurred over the entire disposal site. No recovery occurred during 6 months of sampling and only a slight improvement was indicated by the December sampling. The entire area appeared to be impacted and corner stations did not improve as well as the pelecypods or polychaete worms. Western reference sites had more gastropods compared to the eastern reference site. During the sampling period gastropods also declined at the reference site suggesting a regional trend difficult to explain without more long-term seasonal data.

Number of gastropod species

104. The number of species declined after disposal (Figure 20a) and appeared to show some improvement in December at the western reference site where a greater number of species occurred. However, during the late summer and winter postdisposal sampling the number of gastropod species at the west reference site declined. This poor species representation is comparable to the river influenced estuaries adjacent to Everett but fares poorly in comparison to estuaries of Dyes Inlet and Liberty Bay which shows more than 10 species per 0.05 m^2 grab sample.

Gastropod biomass

105. After disposal gastropod biomass (wet weight) declined (Figure 20b). Like density and number of species biomass did not recover after disposal although station 13 did not appear to be impacted as much as other corner stations. No significant seasonal change in biomass was detected.

Changes in gastropod species

106. The principal species found in the study area were *Mitrella gouldi* and unidentified species belonging to *Barleeia* (had highest frequency amongst gastropod species), *Oenopota*, and *Turbonilla* (Figure 20c and d). Minor occurances of *Polinices lewesii*, *Natica clausi* and *Nassarius mendicus* were also found. After disposal *Barleeia* sp. *Mitrella gouldi*, and *Oenopota* sp. showed declines with very little seasonal improvement. Differences between east and west reference sites for *M. gouldi* were not significant although the highest values were found at the western site. Most of these gastropods are found in the more distant estuaries of central Puget Sound in areas of greater tidal mixing enhanced by the presence of tidal channels and shallow sea bottoms. During the December sampling, *Barleeia* sp. and *M. gouldi* appeared to increase. Because seasonal changes in their numbers and biomass were not apparent, most of these species are considered climax species. Even though *Bittium subplanatum* is the most abundant gastropod in intermediate and deep habitats outside Elliott Bay, this species was found only at the western reference station.

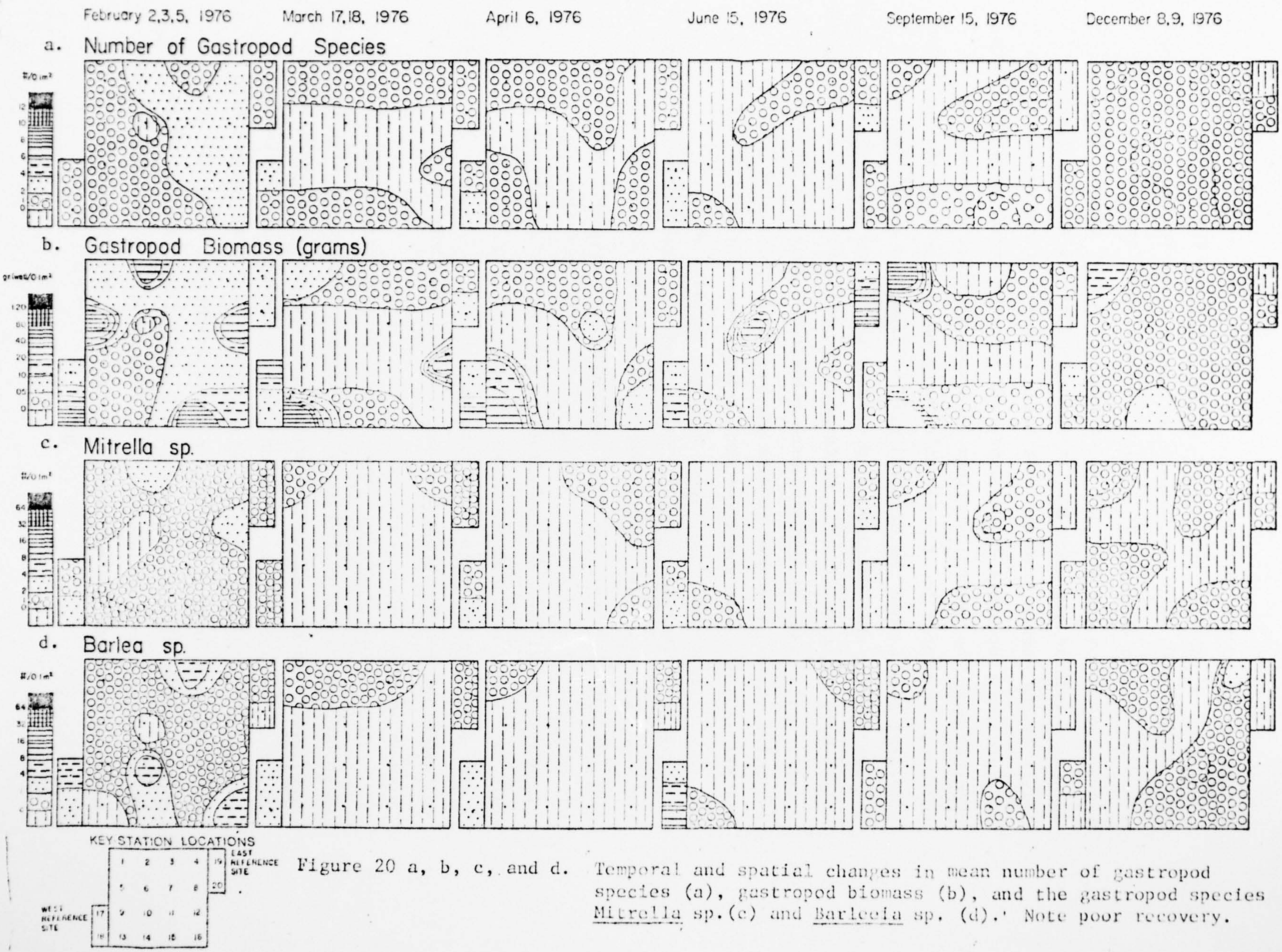


Figure 20 a, b, c, and d. Temporal and spatial changes in mean number of gastropod species (a), gastropod biomass (b), and the gastropod species *Mitrella* sp. (c) and *Barleeia* sp. (d). Note poor recovery.

Changes in pelecypod species

107. Axinopsida serricata. A. serricata was the dominant occupant of the macrofauna in all 60 samples collected prior to disposal (Figure 21a). After the disposal 45 samples contained this species which had experienced a maximum decrease in concentration over central stations 11, 10, and 7 with lesser decreases at the side stations and the least impact on the corner stations. At these corner stations seasonal rate of improvement occurred during June. No seasonal increases or recovery occurred over the central stations or areas of direct disposal impact. In fact, the winter low concentration area appears to have broadened over a greater area within the disposal grid. Although a summer increase occurred during the postdisposal period at the corner stations, their values were not significantly different from predisposal wintertime values. Postdisposal values at the reference sites never exceeded predisposal values. A similar winter to summer decline is described by Lie 1968 despite the presence of small specimens indicating a summer recruitment period. The poor response over the impact area and apparent annual recruitment in the summer suggest a nonbenefited annual classification. Lie 1968 indicates that species with shell size between 2 and 4 mm have life spans of 2 years. Its small size and spherical shape suggest a poor digging ability despite its deposit-feeding activity. Its association with abundant tube-dwelling polychaetes supports Woodin's 1976 hypothesis of the competitive influence of tube dwellers on the nature and size of coinhabitants. The fish gut analysis of dover sole indicate that this species is the second most dominant food item utilized throughout most of the year.

108. A. serricata is most abundant in intermediate depth habitats, 15 to 50 fathoms (30 to 100 m), that have high amounts of organic matter. Predisposal concentrations were normally greater than 128 specimens 0.1 ℓ/m^2, the highest concentration observed during the year being 310 specimens 0.1 ℓ/m^2 (September). Richardson et al. 1977 reports high concentrations at wood rich intermediate depths (47-68 m) off the Columbia River with mean values of 279 and 241 specimens/.1 m^2 in Richardson's faunal groups A_2 and A_4 respectively. These species have low concentrations (less than 32 specimens/0.1 m^2) in estuaries near

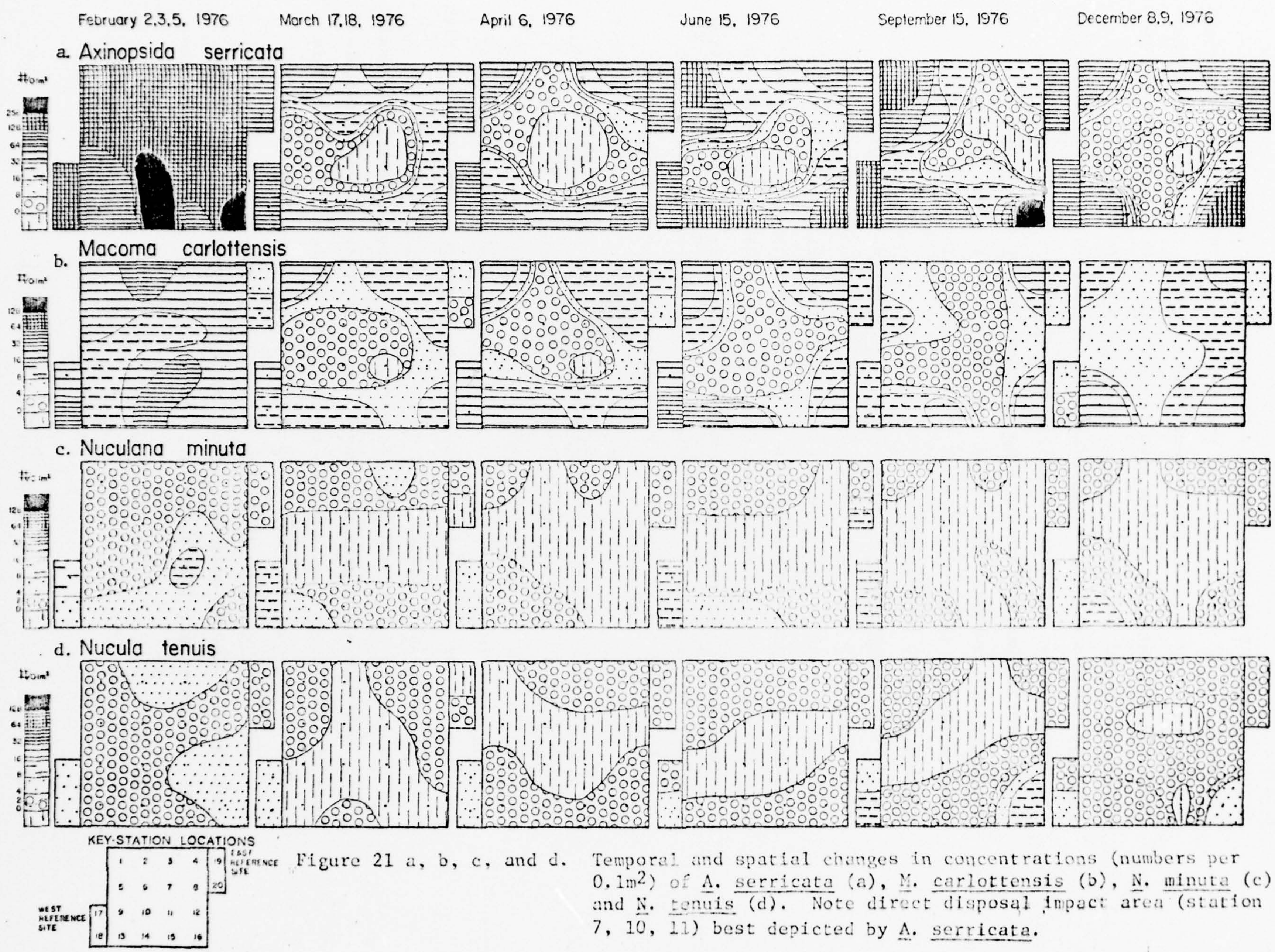


Figure 21 a, b, c, and d. Temporal and spatial changes in concentrations (numbers per $0.1m^2$) of A. serricata (a), M. carlottensis (b), N. minuta (c) and N. tenuis (d). Note direct disposal impact area (station 7, 10, 11) best depicted by A. serricata.

Everett despite similar river-influenced sea bottoms. The reduced concentration of this species and presence and absence of other pelecypods, polychaetes, and foraminiferal species may indicate the influence of the pulp mill discharge of sulfite liquors and plant fiber (Harman et al. 1977). A similar shaped species, Paravalucina tenuisculptis, along with A. serricata dominate the pelecypod fauna in the intermediate depths off the Los Angeles sewer outfall, suggesting that these species are potential organic enrichment indicators. The less frequent occurence of A. serricata in southern Puget Sound compared to central Puget Sound is reported by Lie 1968 and indicates the regional differences of the species in Puget Sound distribution.

109. Macoma carlottensis. After disposal, maximum declines in concentration of this species (Figure 21b) occurred over the central stations or areas directly impacted by dredged material. All 60 predisposal samples contained this species while only 47 postdisposal samples contained the species and by December the number had increased to 58. Before disposal this species was second to A. serricata in pelecypod abundance by a ratio of 8 to 1; after disposal this ratio was reversed over the direct impact stations. The relatively high rate of recovery of M. carlottensis compared to that for A. serricata suggests its greater ability to burrow through the surficial disposal material and possibly the new substrate composition influence on A. serricata. The highest rate of recovery occurred during the June postdisposal period, but like A. serricata this species had high values during the winter predisposal period. The compressed elongate shape of M. carlottensis provides it with a better burrowing characteristic compared to A. serricata. This species is most likely a deposit feeder and its response to the disposal impact makes it a nonbenefited annual. Western reference sites contain more of these species as compared to the eastern reference sites. This species is the most important food item of flatfish in Elliott Bay.

110. M. carlottensis is the dominant pelecypod in the offshore deep (greater 100 m) areas of Elliott Bay and central Puget Sound (Lie 1968, Harman et al. 1974 a, 1977a). Predisposal and postdisposal corner

stations had concentrations normally higher than 16 specimens/0.1 m^2. The highest values, greater than 100/0.1 m^2, reported by Lie 1968 occurred during winter in his deep station near Shilshole Bay. Similar high concentrations are reported by Kisker 1976 although Malkoff 1976 reports Macoma concentrations along with those reported by Harman et al. 1977b were primarily less than 16/0.1 m^2. In Port Gardner, M. carlottensis has higher concentrations in both intermediate and deep habitats. Its greater frequency in Port Susan and greater rate of disposal recovery suggest its higher degree of tolerance to stress habitats. Like A. serricata this species is not reported by Lie 1968 as abundantly in southern Puget Sound compared to central Puget Sound. Lie 1968 found a high degree of patchiness and difference in age composition of this species, suggesting a high degree of predation influencing its variable concentration and age structure. The dominance of this species in the stomach contents of flatfish would support this inference.

111. Nunculana minuta. After disposal most of the grid area showed reduced concentrations of N. minuta (Figure 21c) and no recovery except for the corner stations. These species were found in 51 samples before dsiposal, 27 samples immediately after disposal, and 22 samples by the end of the sampling period. At the western reference site these species were more abundant. Some stations indicated maximum numbers during September but overall no significant seasonal changes were documented suggesting a climax species classification.

112. N. minuta is most characteristically found at intermediate depths outside Elliott Bay in substrates containing mud, sand, and gravel. In central Puget Sound and in Port Gardner this species decreased near river habitats or in areas of increased muds. Its shape suggests a more fixed position within the sediment typical of suspension feeding pelecypods. However, its relatively good recovery at corner stations immediately after disposal comapred to most other pelecypods indicated its ability to burrow through disposed material.

113. Nucula tenuis. This species was found in 49 samples prior to disposal, declined to 20 after disposal, and showed a high rate of improvement to 36 samples by the end of the December sampling (Figure 21d). No recovery occurred over the central stations 6 and 7.

Recovery rate over the entire disposal grid was highest between the September and December sampling. This species was most abundant at the western reference site but showed nosignificant seasonal changes. Its relatively high rate of recovery during the 9-month sampling period suggests seasonal recruitment. In central Puget Sound this species is more typical of the deep basin habitats where it is ubiquitous over many substrates. This species was absent in most areas of Port Susan and Port Gardner. Off the Columbia River this species was more frequent in the muddy deeper habitat (Richardson et al. 1977).

114. M. moesta alaskana. Prior to disposal this species was found in 24 samples and showed marked improvement to 30 and 31 samples in September and December (Figure 22a). This species was most abundant at the western reference site and showed overall increases during June and December. In the recolonization study off the coast of Washington, Richardson et al. 1977 also indicated a relatively good recovery rate of this species attributed to its good digging shape. This species may be classified as a benefited annual.

115. Nemocardium centifilosum. Prior to disposal this species was found in 20 samples reduced to 3 samples after disposal, and showed no postdisposal improvement (Figure 22b). It was more frequent at the western reference site than the eastern reference site. Its inflated or near spherical cross sectional shape and ornamented surface suggests an epibenthic nature similar to the epibenthic shallow water occurring Clinocardium nuttalli. N. centifilosum is most likely a suspension feeder. Its poor recovery rate, lack of seasonal changes and preferred habitat outside Elliott Bay suggest that it is an expatriated climax species classification.

Other pelecypod species

116. The rare occurrence of Megacrenella columbiana, its association with the pelecypods N. centifilosum and N. minuta outside Elliott Bay and its suspension feeding epibenthic nature would suggest this species expatriated climax species response to disposal material. Other pelecypod species showing marked reduction after disposal were Cardiomya oldroydi,

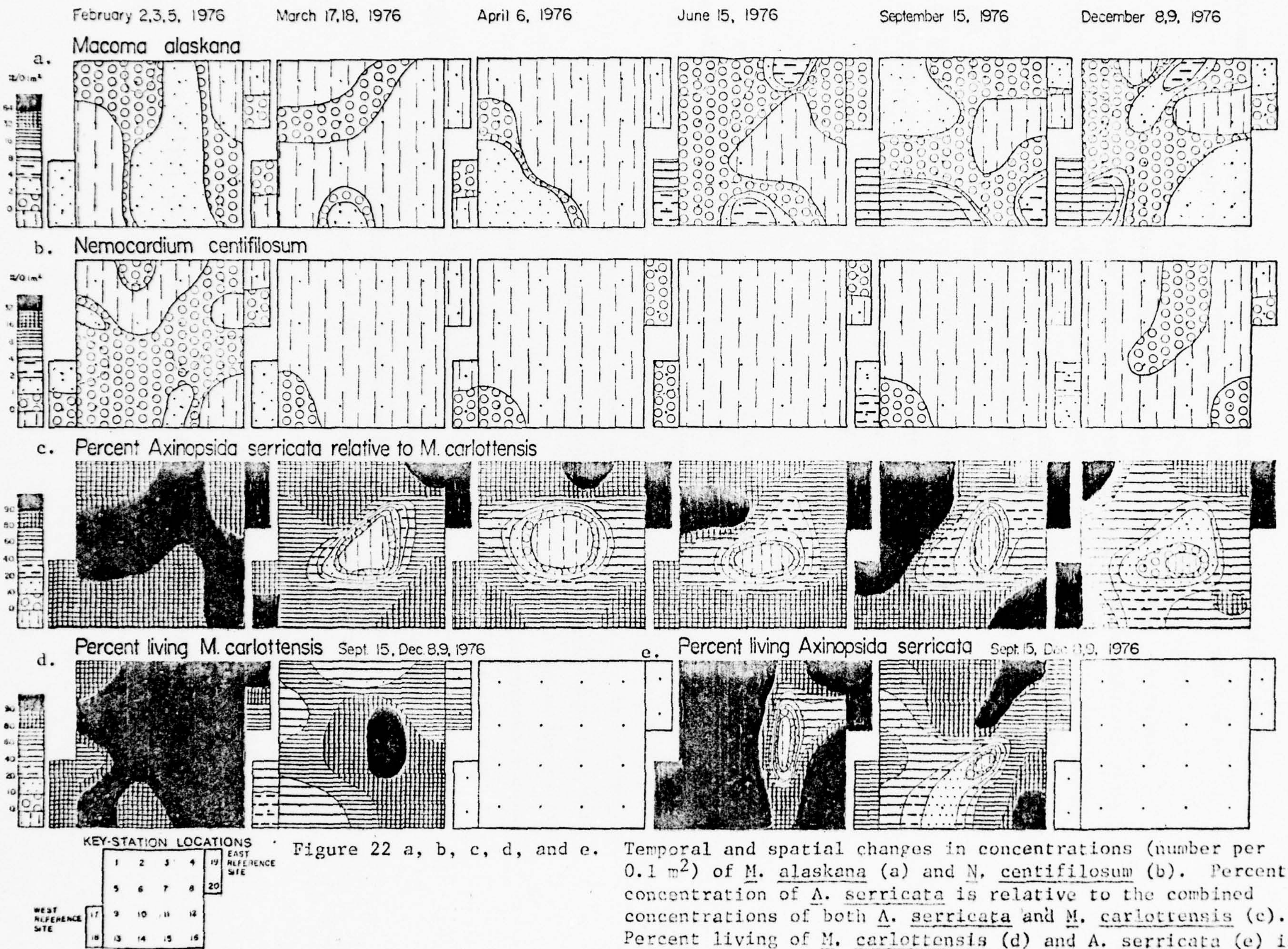


Figure 22 a, b, c, d, and e. Temporal and spatial changes in concentrations (number per 0.1 m^2) of M. alaskana (a) and N. centifilosum (b). Percent concentration of A. serricata is relative to the combined concentrations of both A. serricata and M. carlottensis (c). Percent living of M. carlottensis (d) and A. serricata (e) is relative to both their living and dead shell concentrations.

and the large clam Compsomyax subdiaphana. C. subdiaphana is an infaunal species but has very poor digging shape possibly explaining its poor recovery. Large specimens have been observed in Port Orchard of the R-4 community. Species that prefer more sandy, gravelly, turbulent water habitats such as Astarte spp. and pectins were rarely found in the study area. Specimens normally found in deep, muddy habitats of central Puget Sound such as Pandora filosa, Lyonsia californica, L. pugettensis, Lucinoma annulata, and Paravalucina tenuisculpta were rare in the study area. Species more typical of the muddy, shallow habitats of Elliott Bay, such as Macoma nasuta and Psephidia lordi were also rarely encountered in the study. Ascila castrensis, a species that dominates muddy sea bottoms in Port Madison and Port Orchard, was extremely rare in the study area suggesting its avoidance of woody substrates.

Impact on temporal and spatial distribution of molluscans

117. The seasonal concentration plots of molluscans appeared to best indicate the relative impact of the disposal material on the molluscan fauna. Species that did not recover were mainly those normally occurring in preferred habitats outside Elliott Bay such as the pelecypods, Nemocardium centifilosum, Nuculana minuta and Megacrenella columbiana and the gastropods Bittium subplanatum, Mitrella gouldi, Barleeia sp. and other gastropod species. Most of the other normal occupants also showed a poor recovery over the direct impact areas but showed slight seasonal changes in corner stations and reference stations; these nonbenefited annuals were Axinopsida serricata, Macoma carlottensis, M. moesta alaskana, and Nucula tenuis. Of all molluscan species M. moesta alaskana and M. carlottensis showed high rates of improvement, recruitment occurring during the summer months. These species might be benefited annuals.

Changes in Axinopsida serricata relative to Macoma carlottensis

118. Another method of delineating the direct impact of the disposal material is to look at the percent of A. serricata relative to M. carlottensis (Figure 22c). The relative percentage of M. carlottensis

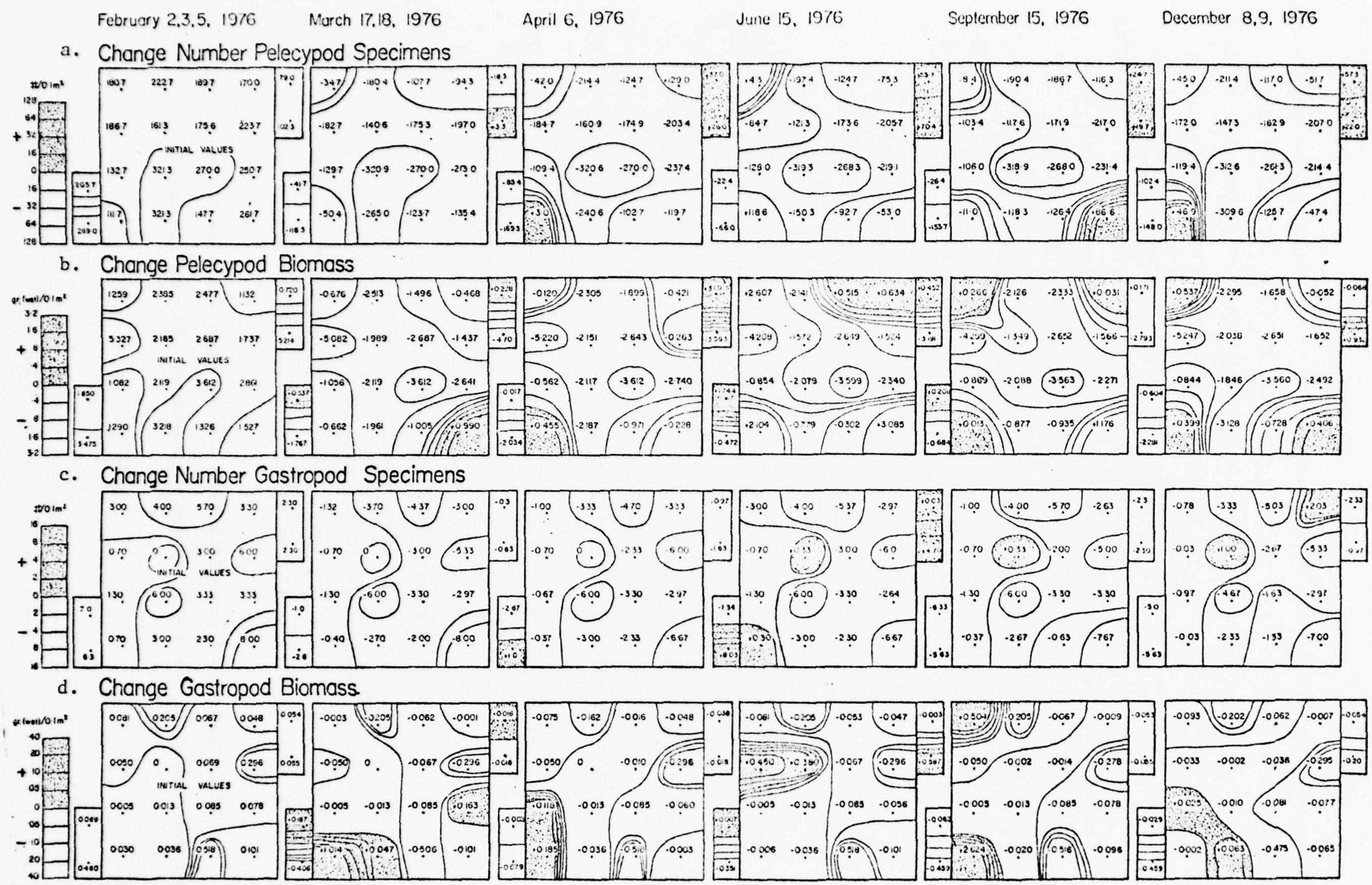
increased over the direct impact site during the sampling period suggesting the relative decline in A. serricata. Prior to disposal, A. serricata was eight times more abundant than M. carlottensis and by the end of the sampling period this ratio was nearly reversed. At the reference sites the ratio between these species remained constant. Another approach to assessing the relative disposal impact was to determine the percent living relative to dead and living specimens of both M. carlottensis and A. serricata (Figure 22d). Although this was not measured during all the sampling periods, a higher percentage occurred in September compared to the December sampling at both disposal and reference sites suggesting the influence of recruitment or greater frequency of living specimens during the summer months.

119. M. carlottensis does not appear to be as greatly impacted as A. serricata. The difference may be due to either its better digging characteristics, its greater tolerance for wood debris and associated increased contents of H_2S. In addition, the occurrence of M. carlottensis in the stressed areas of Port Gardner and the near absence of A. serricata also supports this view of greater tolerance for more stressed conditions.

Change from predisposal values

120. Changes in concentrations of pelecypods from predisposal values (Figure 23a) indicated the maximum change over stations 10, 11, and 14 and only corner stations 13, 4, and 16 showed increases beyond predisposal values (positive changes). At the eastern reference station post disposal values increased beyond predisposal values (positive changes). At the western reference station no improvements over predisposal values were indicated (negative change). The cause for these differences is unknown; perhaps it is related to the 10-year major flood that occurred in late winter. Changes in the biomass of pelecypods (Figure 22b) showed a greater decrease over the impact areas, especially at station 11. The greatest rate of improvement occurred at corner station 1, 4 and 13 during the summer.

121. Gastropod concentrations and biomass relative to predisposal values showed little postdisposal improvement (Figure 23c and d).



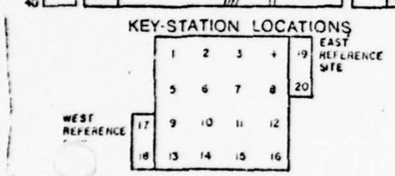


Figure 23 a, b, c, and d. Temporal and spatial changes in differences between initial and postdisposal concentrations and biomass for erranteans and sedentarians. Stippled symbols indicate postdisposal samples that had higher values compared to redisposal (initial) values.

However, reference stations showed significant improvements relative to the predisposal values, again suggesting some seasonally operant regional factor influencing the Elliott Bay fauna.

Weight changes in molluscans

122. Plots of pelecypod biomass per number of specimens for both total pelecypods and M. carlottensis showed a high variability and no distinct trends (Figure 24a and b). Larger specimens appeared to be more frequent during the summer months. Unusually low values occurred during the December sampling that would suggest the presence of greater numbers of juveniles. However, this trend is not substantiated by density increases, which were more apparent during the summer months. One would expect a greater weight per specimen immediately after disposal if large burrowing specimens are more capable of resurfacing through the disposed material when compared to smaller specimens. However, the trend was just the oppostie with small specimens occurring over the impact site. The high degree of variability and the combining of all pelecypods species probably explains these anomalous trends. It is hoped that the computer analysis of the data will analyze these weight/specimen trends and the species level.

Spatial and Temporal Changes in Polychaete Worms

Density of sedentarian

123. After disposal sedentarians (Figure 25a) were nearly absent over the directly impacted central stations (10, 11, and 7) and the marginally impacted stations (9 and 2). These low concentrations occurred until April despite slight increases at reference sites during the period between March and April. Recovery began in June over the disposal grid primarily at corner and side stations. Unlike most pelecypods sedentarian polychaete densities recovered beyond predisposal values with recruitment occurring over the directly impacted stations during the summer. The improvement was caused by the addition of opportunistic polychaetes and the seasonal recruitment of normal occupants. The eastern portion of the disposal grid had relatively

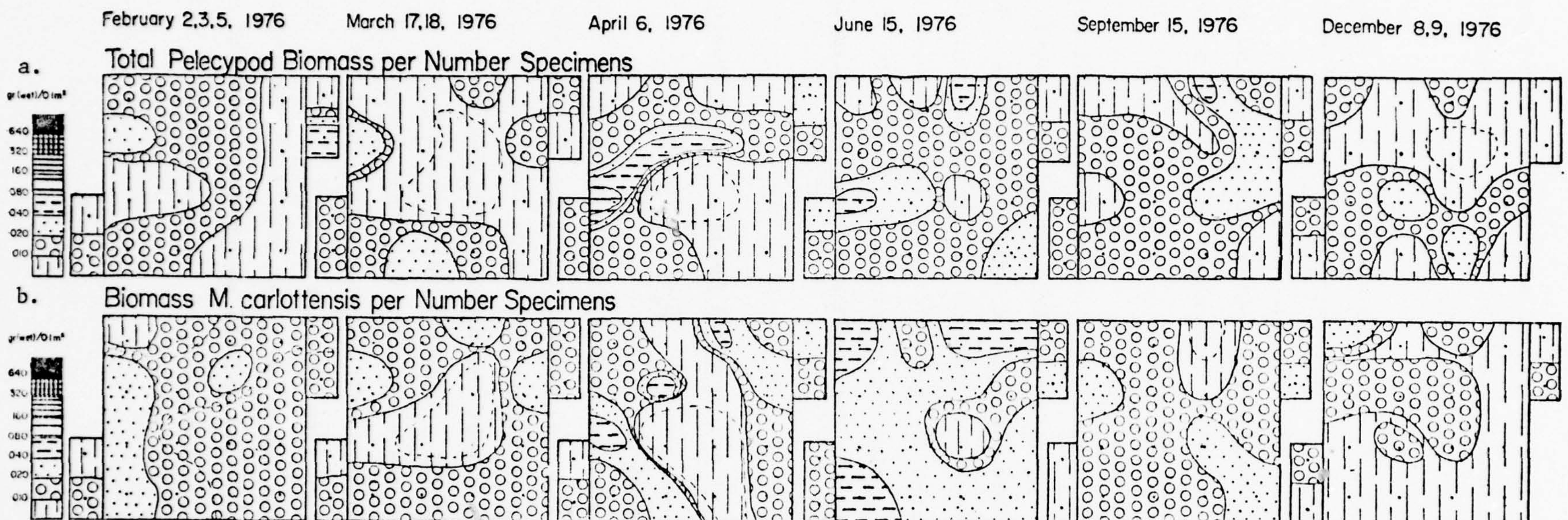


Figure 24 a and b. Temporal and spatial changes in the total pelecypod (a) and M. carlottensis (b) biomass per number specimens. Low values indicate small specimens or juveniles.

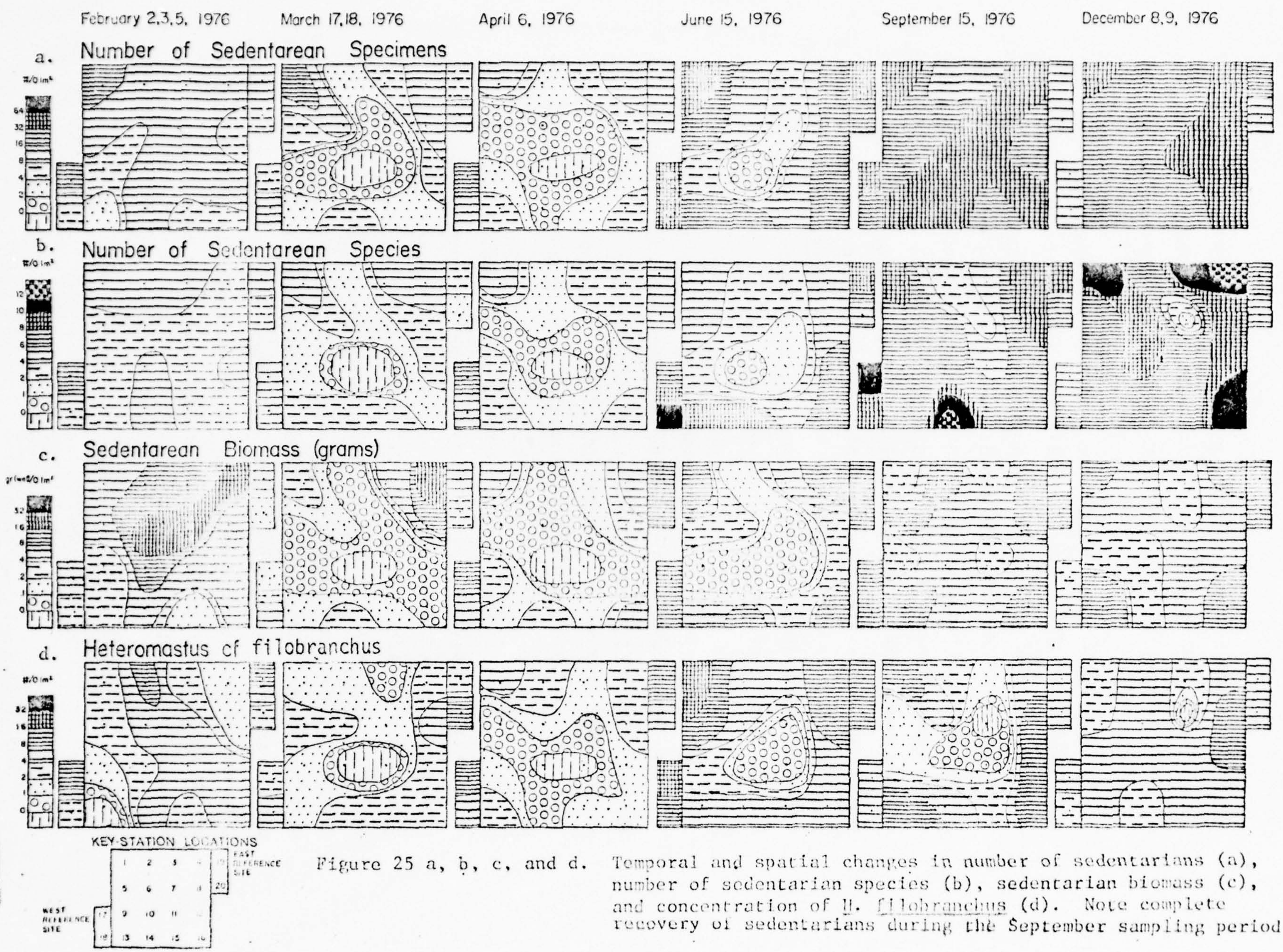


Figure 25 a, b, c, and d. Temporal and spatial changes in number of sedentarians (a), number of sedentarian species (b), sedentarian biomass (c), and concentration of H. filobranchus (d). Note complete recovery of sedentarians during the September sampling period.

high values and species composition which suggests in the influence of the Duwamish River. A winter decline occurred over both disposal and reference sites. No difference appears to occur between east-west reference sites.

124. Predisposal winter mean densities were low (less than 15/0.1 m^2) compared to those reported by Lie 1968 and Nichols 1974 but similar to those reported by Malkoff 1976 in the stress habitat of Port Gardner. The presence of abundant wood debris dominance of the tube dwellers and the abundance of small clams may inhibit the development of dense polychaete communities. In Puget Sound highest densities (greater than 128/0.1 m^2) are found in the Duwamish River and forset beds of river deltas. Richardson et al. 1977 also found high densities (greater than 200/0.1 m^2) in wood-rich muds off the Columbia River where Heteromastus filobranchus dominated the sedentarian polychaetes, the same species that frequents Elliott Bay and organic-rich areas of Puget Sound.

Number of sedentarian species

125. The number of sedentarian species (Figure 25b) was reduced over the impact area after disposal. Recovery began in late spring and recovered beyond predisposal values during the summer when opportunistic species were introduced over disposal sites. A seasonal increase in the summer also occurred at the reference sites but unlike the disposal grid stations declined during the winter.

126. Comparison of number of species with those of Lie 1968 and Nichols 1970 is difficult since their data are the total summation of replicates, while this study uses average per replicate. Comparisons are further complicated with other Puget Sound studies since worms are described only to family (Malkoff 1976, Harman et al. 1974 , 1977a) or grab sample sizes are significantly different. Because of these problems most benthos macrofauna studies use diversity indexes which are less influenced by sample size. In this Puget Sound study number of species increased in organic accumulation sites and decreased in compact wave-sorted sands, river channel sands, or deep basin muds more distant from nearshore sediment sources.

Sedentarian biomass

127. Biomass (wet weight) also had a marked reduction over the impact area and the rate of recovery appeared to be slower than that of either concentration or numbers of species (Figure 25c). Slower recovery rates reflect the smaller size of opportunistic species. Greatest values occurred during the late summer and decreased to levels well below predisposal by December. At the reference stations no significant difference occurred between the eastern and western biomass values with the values being generally high, reflecting the contribution of large worms or climax species which normally have larger biomass. Biomass values were generally lower than those reported by Lie 1968.

Changes in sedentarian species

128. Heteromastus filobranchus. The capitellid, H. filobranchus, showed no uniform distribution over the predisposal site (Figure 25d). After disposal a marked reduction occurred over the entire disposal grid site, maximum changes occurring at stations 10 and 11, indicating the region of maximum disposal impact. Recovery occurred mainly in June at corner stations while slower rates were present at the major impact stations 7, 10 and 11. By December recovery was complete except for station 7, the maximum impact station. No significant differences between the east and west reference sites were discernable; maximum concentrations occurred during the June sampling. The seasonal recruitment and poor recovery over the direct impact site indicates that this species is a nonbenefited annual. Fauchald and Jumars (In press) indicate from their literature review of worm feeding modes that most capitellids are motile nonselective deposit feeders. They state that H. filobranchus "build horizontal or vertical tubes stretching up to 15 cm below the surface..." which "allows the worm to feed in black anoxic muds getting the necessary oxygen from the overlying waters by irrigation." This species deep substrate occurrance may be a factor in its relative high recovery rate over the disposal site.

129. H. filobranchus seems to prefer organic-rich substrates, especially associated river-influenced habitats or stressed habitats. Mauer et al. 1974 suggested H. filobranchus might be considered

an opportunistic species based on a disposal study at the mouth of the Delaware River. Rosenberg 1972 also reported that this species responded to cessation in pulp mill discharge. The decline of this species on the forset beds of the river delta adjacent to the Everett pulp mills also indicates this species' sensitivity to stress caused by either the river or pulp mill effluents. A decline in this species occurring over a disposal site in the Delaware River was reported by Leatham et al. 1973 thereby suggesting a nonbenefited annual response. Unidentified capitellids reported by Lie 1968 were most frequent in his station 2, near the freshwater influenced bay. A similar trend was also reported on by Harman et al. 1977a. Richardson et al. 1976 lists this species as being most abundant in the wood-rich muddy sands off the Columbia River.

130. Ammotrypane aulogaster. The opheliid, A. aulogaster, was rarely found in predisposal samples (Figure 26a) yet was abundant during the summer primarily over the immediate impact area (Stations 7, 10, and 11). Following this increase a moderate decline in species occurred between September and December. A similar abundant increase did not occur over the reference site, although low concentrations were found during the summertime. The increased abundance of this selective opportunistic species over the dispsoal site was also followed by its increased occurrence in stomachs of dover sole during the summertime. Their decline over the disposal site during the fall was probably due to selective feeding by flatfish. Sea bottom concentrations were not significantly high at any reference site in order to make an adequate comparison between these areas. However, stomach analyses indicated greater frequency of these worms in flatfish at the eastern reference site.

131. Ammotrypane aulogaster is found in the Everett area associated with accumulation sites of wood debris especially on the forset beds of river deltas. High concentrations with a patchy distribution and an associateion with river-influenced habitats suggest that this species has a high reproductive potential, a high mortality rate and exists in habitats characteristic of opportunistic species. Oliver et al. 1976 reported Armanda brevis, an ophelid that is morphologically similar to

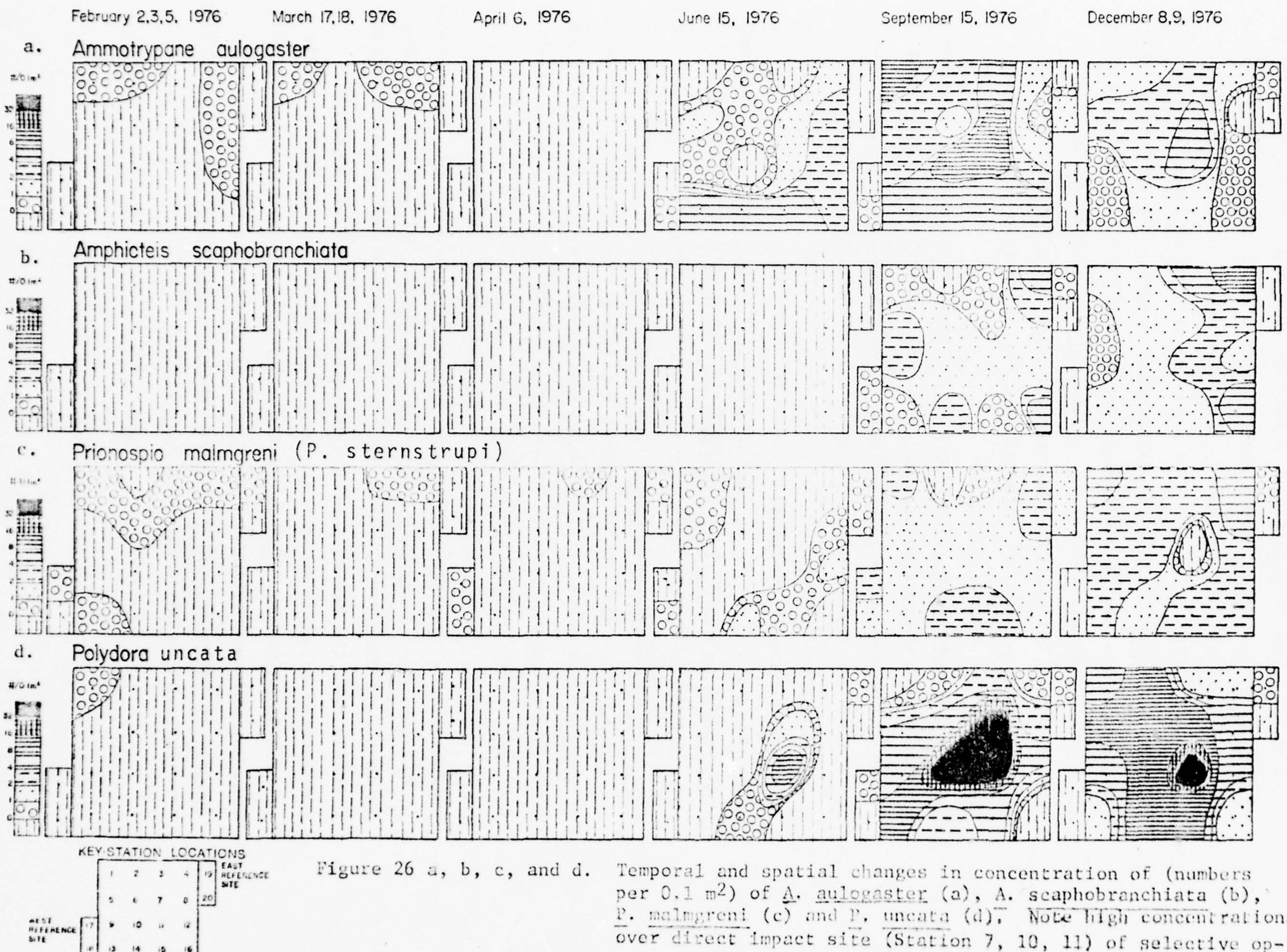


Figure 26 a, b, c, and d. Temporal and spatial changes in concentration of (numbers per 0.1 m^2) of A. aulogaster (a), A. scaphobranchiata (b), P. malmgreni (c) and P. uncata (d). Note high concentrations over direct impact site (Station 7, 10, 11) of selective opportunists A. aulogaster and P. uncata.

this species, as an opportunistic species with high larval water column availability. A. brevis has a distribution in Elliott Bay and Shilshole Bay mainly confined to nearshore, river-influenced habitats (Lie 1968, Harman et al. 1974 , 1977a). The presence of both of these species with high concentrations on the Snohomish Delta suggests the greater stress condition of that delta compared to the more distant Stillaguamish River delta (Harman et al. 1977b). A. aulogaster was also frequent in a Swedish fjord, influenced by former pulp mill activity, Rosenberg 1968. Most opheliids are regarded as a motile surface deposit feeders (Fauchield and Jumars, in press).

132. Amphicteis scaphobranchiata. A. scaphobranchiata (Ampahretidae) was not observed prior to disposal but occurred six months after disposal during the September sampling (Figure 26b). Increases occurred during the winter especially on the eastern side of the disposal station grid suggesting the influence of the Duwamish River. This species was found only in low numbers at the reference sites in September but was not observed in the December samples despite its increase over the disposal site. Based on its uniform distribution over the disposal grid and relative absence at the reference sites prior to disposal, this species is considered a nonselective opportunistic species.

133. This species is found in Puget Sound on the upper portion of the forset beds on the Stillaguamish River Delta. It is believed to be a sessile selective surface deposit feeder (Fauchald and Jumars, in press) and lives in a flexiable mud tube (MF9).

134. Prionospio malmgreni.* The spionid, P. malgreni, showed relatively low concentrations before disposal but during the post disposal period exhibited a steady increase (Figure 26c). The December sampling exhibited levels beyond predisposal levels. The absence of this species directly over the direct impact site, stations 7 and 11, suggests competitive interaction with the more abundant selective opportunistic species found there. No significant difference in concentration between the east and west reference sites was observed. The increase of this species in September and the marked decrease in December at the reference

*P. malgreni is now designated P. sterstrupi

sites, which suggests that this annual was benefited by the presence dredged material.

135. This species is known to inhabit various sediment substrates in Puget Sound but appears to prefer soft bottom sediment and is reported to be commensal with the heart urchin, Brisaster townsenii (Lie 1968). Its presence in Port Gardner in H_2S rich sediment suggested its ability to withstand stressed sea bottoms. Lie 1968 identifies this species as a deposit feeder. Most spionids are regarded as descretely motile surface deposit feeders (Fauchald and Jumars, in press).

136. Polydora uncata. Polydora uncata (Spionidae) showed the most dramatic increase over the direct impact stations (7, 10, and 11) in September (Figure 26d). This species was found only at one station prior to disposal and began to first populate stations 7 and 10 in June, attained maximum concentration during September and decreased to more uniform moderate concentration during December. This species' lower numbers at the corner stations suggest the competitive role of normal occupants in preventing the establishment of P. uncata at the corner stations. Corresponding to the decline in these opportunistic species was an increase in predatory worms, which suggests a possible prey-predator relationship. P. uncata was not found in the flatfish stomachs. No corresponding high concentration of this species occurred over the reference site and no significant differences in concentrations occurred between reference sites. The distinct summer increase over the impact stations and apparent fall decline over the impact areas suggest a selective opportunistic species classification. This species is regarded as a surface deposit feeder.

137. P. uncata was observed in the uppermost portions of the Duwamish River channel between 14th Avenue bridge and Slip 6 (Figure 12). P. ligni is reported by Slotta et al. 1973, 1974 in Oregon estuaries as being an opportunistic species. On the east coast P. ligni is also reported by Saila et al. 1971, Pratt et al. 1973 and Grassle and Grassle 1973. P. uncata was not reported by Lie 1968, who instead reported P. matrix, P. caeca and P. caullery. P. uncata leaves a conspicious

U-shaped tube made of fine sand and mud having a typically rust color. The tubes are so abundant that they alter the uppermost surface substrate texture which may influence activities of other organisms.

138. Laonice cirrata. Laonice cirrata (Spionidae) was found in all stations prior to disposal at low concentrations (Figure 27a). After disposal its concentration was mainly found at corner stations suggesting an ability to burrow through any disposal layer found there. A slight improvement in this species occurred in the winter sampling. No significant seasonal changes in concentrations occurred at either the reference sites or over the disposal site. There appeared to be some indication for its preference to the eastern reference site. Because of its large size, poor recovery, and lack of significant seasonal recruitment this species is considered more typical of a climax species.

139. Lie 1968 reports this species to occur more frequently in soft sediment or fine sand. In the Shoreline study of central Puget Sound and Everett this species is more typical of deeper habitats associated with the heart urchin Brisaster townsendii. L. cirrata was observed in mucous tubes MM3 its mode of feeding is most likely that of surface deposit feeder.

140. Praxilella gracilis. P. gracilis (Maldanidae) had predisposal low concentrations and showed no marked seasonal changes (Figure 27b). During the postdisposal phase no recovery was apparent. A slight seasonal increase in concentration at the eastern reference site was suggested during the summer sampling. This species' large size, poor recovery, and absence of significant seasonal increases in numbers or biomass indicate characteristics belonging to a climax species. Fauchald and Jumars (in press) indicate most maldanids are deposit feeders.

141. Lie, 1968 reports this species as a deposit feeder occurring abundantly in sandy silts of Port Madison in his station 4. Mud tubes are normally found associated with this species. Another mud-tube-dweller maldanid is P. affinis which was rarely found in the Shoreline study. It has a typical thick mud tube (MR7 and 15) and is frequently

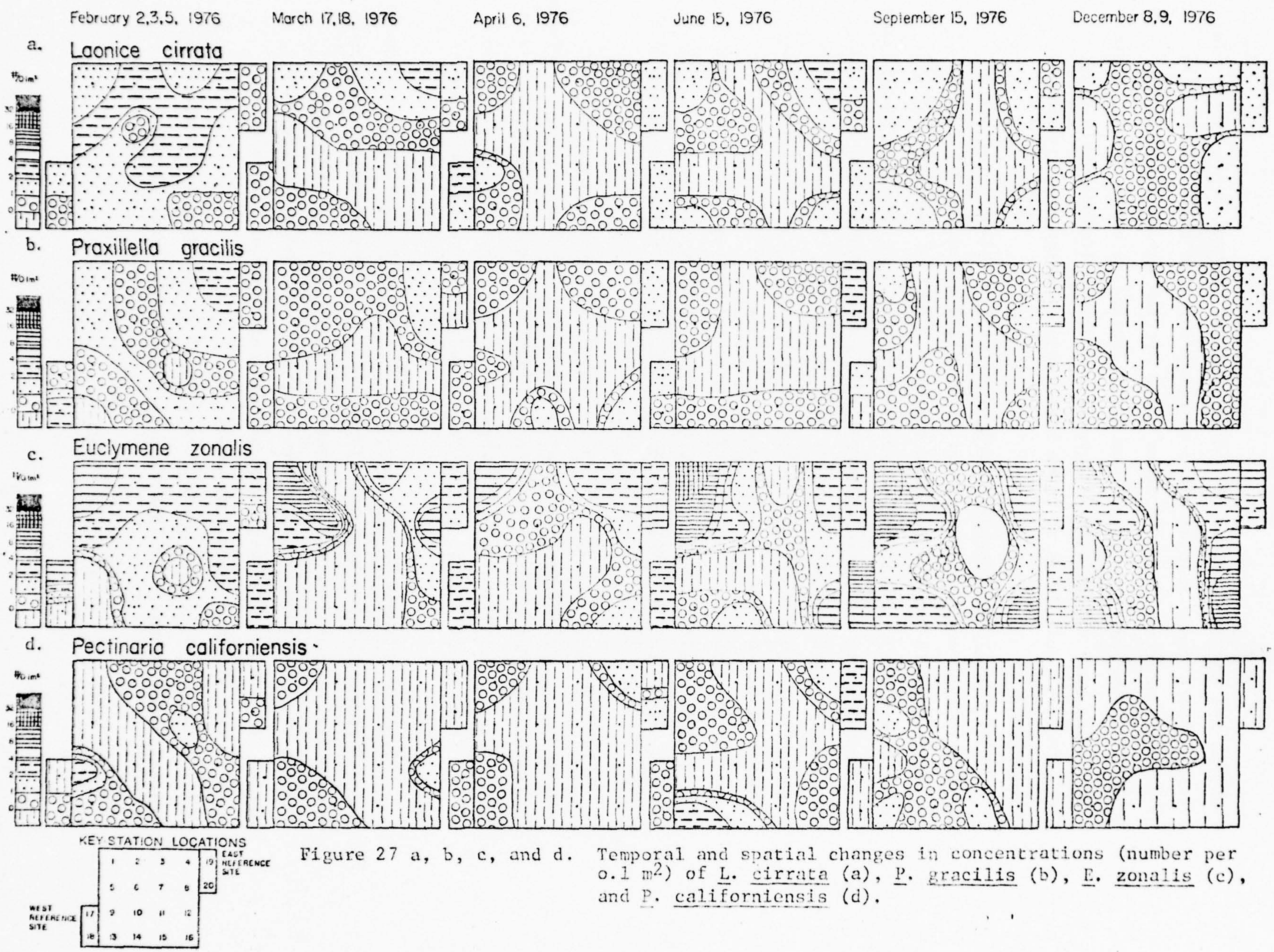


Figure 27 a, b, c, and d. Temporal and spatial changes in concentrations (number per 0.1 m^2) of L. cirrata (a), P. gracilis (b), E. zonalis (c), and P. californiensis (d).

found in the deeper portions of Elliott Bay and central Puget Sound. The rarity of both these species after disposal suggests their sensitivity to dredged material. In Port Susan these species were absent despite abundant empty mud tubes suggesting their decline in basin areas. These basin areas were at one time influenced by sulfite liquors waste that had sufficient quantities to cause high oyster abnormalities (Cardwell et al. 1976).

142. Euclymene zonalis. Euclymene zonalis (Maldanidae) had a relatively high concentration prior to disposal and after disposal a marked decline in numbers occurred throughout most of the disposal grid area (Figure 27c). This lack of recovery primarily over the direct impact site suggests its avoidance or competitive exclusion from the areas that were high in opportunistic species. Concentrations showed a seasonal increase in September at reference sites and corner stations. Abundance of the sand tubes (SR-7) in the summer also suggests the species' seasonality. Because of this species' poor recovery directly over the impact site, seasonal recruitment, and rapid recovery around the margins, this species is considered to be a deposit feeding nonbenefited annual.

143. E. zonalis, along with its empty worm tubes, dominates the eastern portion of Elliott Bay suggesting its preference for river-influenced habitats. In the Everett area this species is found in a variety of habitats, principally areas with apparent organic enrichment. Lie 1968 reports this species as a deposit feeder being rare or absent in muds and gravels.

144. Pectinaria californiensis. P. californiensis (Pectinariidae) had low concentrations over the disposal site in predisposal samples and showed little post disposal improvement (Figure 84d). No seasonal changes were observed or differences between east and west reference sites. Because of its large size and lack of seasonal trends this worm is considered a climax species.

145. P. califoriensis is more typical of the deep basin areas of central Puget Sound. Lie 1968 reports this species most abundantly

in both central and southern Puget Sound stations 2 and 7. Nichols (1974) discussed the role of this deposit feeding worm in turning over bottom sediment.

146. Aricidea longicornuta. A. longicornuta (Paraonidae) was extremely rare in predisposal samples and not until summer and fall did it increase in numbers (Figure 28a). Its relatively high concentration on the east portion of the disposal grid suggest the possible influence of the Duwamish River. Not enough long-term seasonal samples were collected to adequately determine whether this species is a deposit feeding benefited annual or nonselective opportunistic species. Lie 1968 does not report this species, he instead lists A. lopezi and A. ramosa.

147. Trichochaeta multisetosa. T. multisetosa (Disomidae) like A. longicornuta, had low concentrations prior to disposal and showed increases during the September and, especially, winter sampling (Figure 28b). Concentrations of this species were relatively higher on the eastern portion of the sampling disposal grid again suggesting the influence of the river suspended load sedimentation. The appearance of this species at the eastern reference site and absence from the western site also suggests this river influence during the December sampling. Lie 1968 does not report this species. More information is needed in order to discern whether this species is a benefited annual of (most likely) a non-selective opportunistic species. Most disomids are surface selective deposit feeders (Fauchald and Jumars, in press).

Other sedentarian species

148. The frequently reported opportunistic species C. capitata was rarely found over the disposal grid despite its dominance in the upper portion of the Duwamish River channel (Figure 14). Another abundant species occurring in the river channel, Cirratulus cirratus also did not recolonize the disposal site as an opportunistic species as one might have expected. Although Abarenicola pacifica was found in the uppermost portion of the Duwamish River channel only one specimen was found over the disposal site. This scaricity suggests its

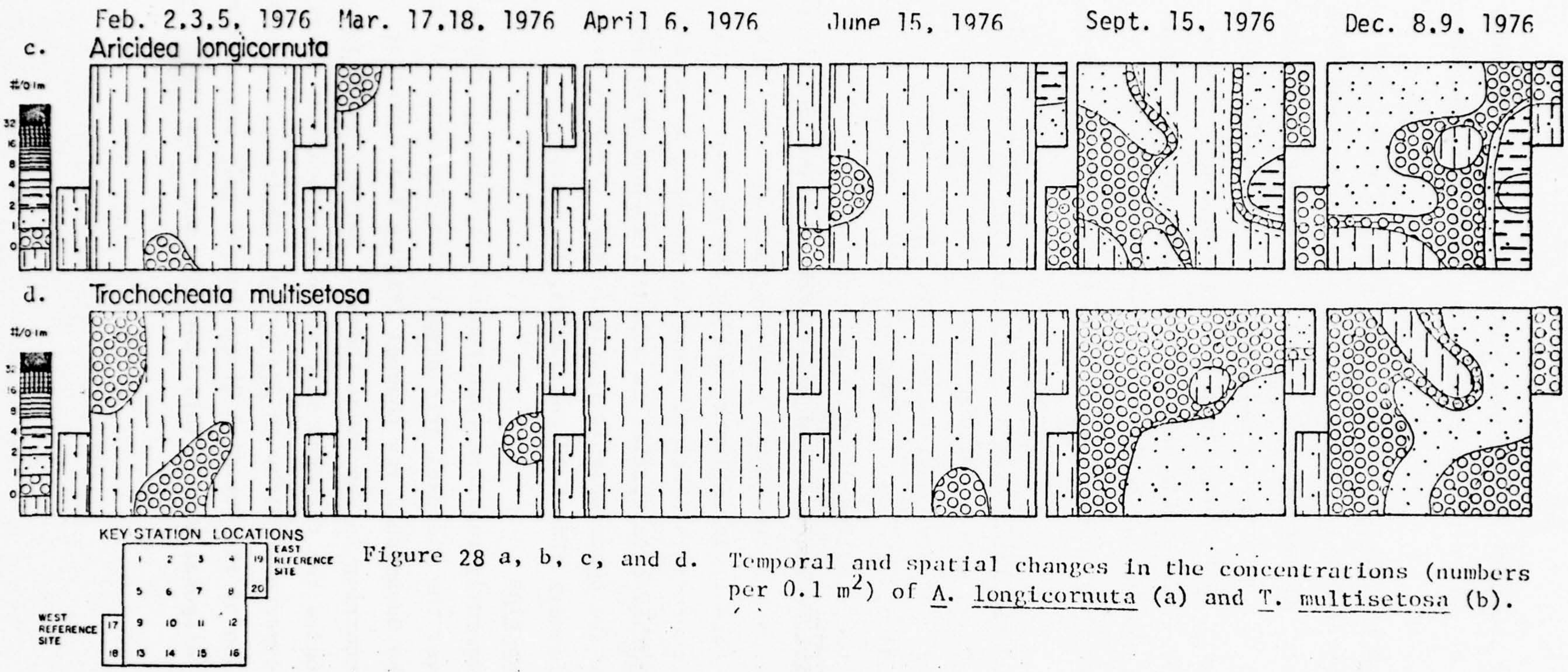


Figure 28 a, b, c, and d. Temporal and spatial changes in the concentrations (numbers per 0.1 m^2) of A. longicornuta (a) and T. multisetosa (b).

lack of an opportunistic tendency to recolonize the disposal site and its lack of transportation to the disposal site during dredging. Other species such as Oweniia fusiformis, which is commonly found in nearshore habitats or river-influenced tideflats, was rarely sampled over the disposal site. Another Oweniidae, Myriochele heeri, was occasionally found, but no significant recovery or distribution trends were observed. Another river or tideflat associated species, Haploscoloplos elongata, was rarely found over the disposal site. Thus, many sedentarian species that occur in stress habitats did not respond as opportunistic species over this deep disposal site.

149. The large tube dwelling maldanid, Asychis similis, and other smaller maldanid species such as Nicomache lumbricalis and Maldane glebifex were occasionally sampled, but no distinct trends at either the reference site or disposal site were discernable. Ampharetids, Ampharete goesi and Melinna cristata were also found over the disposal site but again showed no temporal or spatial distribution trends. A few tubes belonging to Spiochaetopterus costarum and Phyllochaetopterus prolifica were found at both reference and disposal sites, but no distribution trends were discernable. Sedentarians that are abundant in organic-rich mud in shallow embayments and trichobranchids, Terebellide stroemi and Trichobranchus glacialis were rarely sampled over the disposal site. The opheliids, Travisia brevis and T. pupa, as well as the magelonid Magelona japonica were rarely sampled at either the reference or disposal site stations. Chaetozone setosa which is frequently sampled is more gravelly coarse, sand current-swept areas, was rarely sampled at either the disposal or reference sites in this study.

Density of erranteans

150. Errantean polychaete worm densities were markedly reduced over the central stations (7, 10, and 11) for at least 4 months after disposal (Figure 29a). During the summer months corner and side stations showed marked increases in concentrations; by winter these concentrations were generally higher than predisposal levels. A progressive increase in the erranteans occurred during the summer

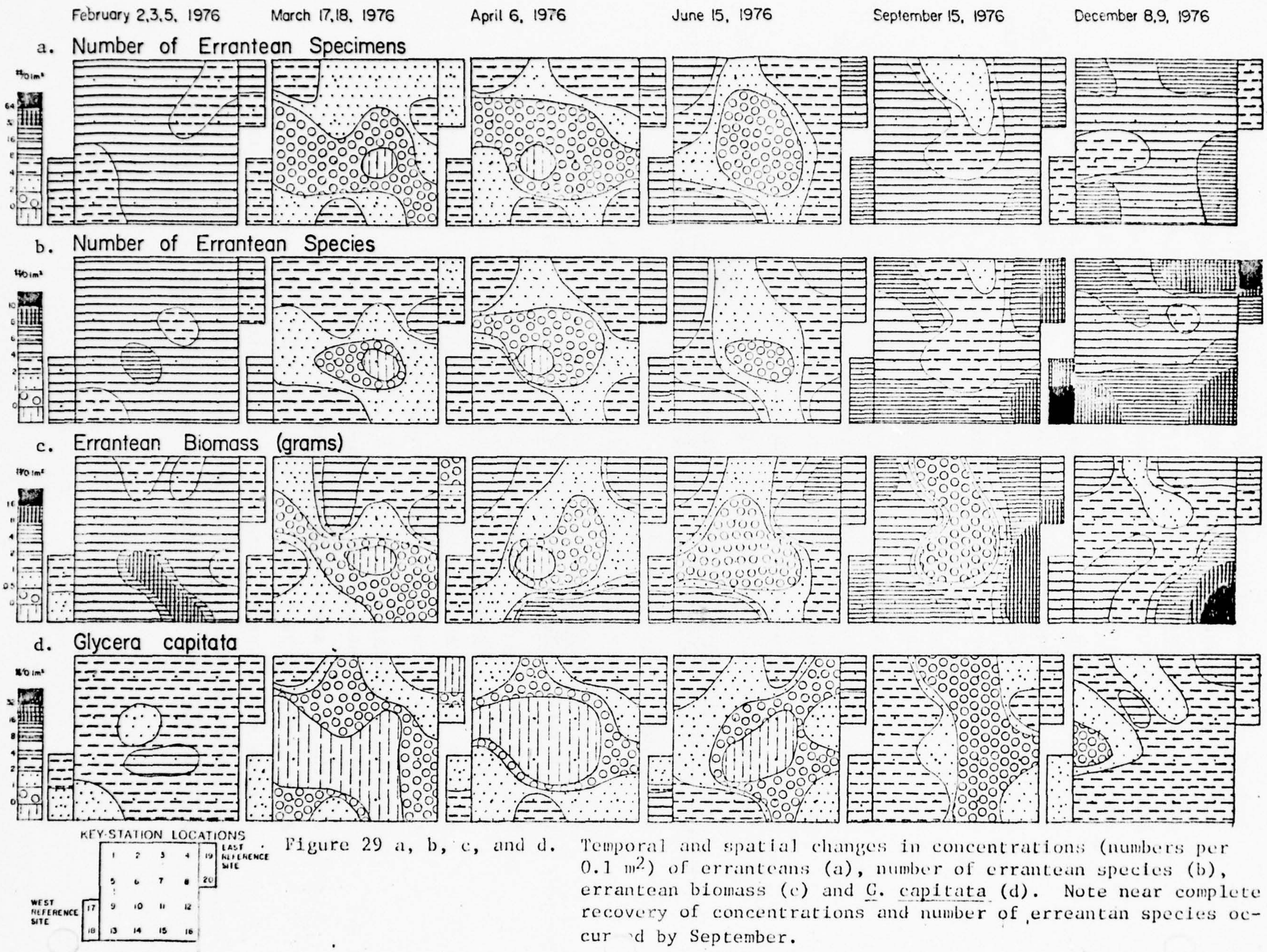


Figure 29 a, b, c, and d. Temporal and spatial changes in concentrations (numbers per 0.1 m^2) of erranteans (a), number of errantean species (b), errantean biomass (c) and G. capitata (d). Note near complete recovery of concentrations and number of erreantan species occur d by September.

and winter months over the disposal grid stations. At the reference stations high numbers also occurred during the summer but, in contrast with the disposal site, declined during the wintertime. This trend is attrubuted to the increase in predatory errantean worms filling voids left by the impacted nonbenefited annuals and climax species. A winter recruitment for predatory worms might be suggested but the winter decline of erranteans at the reference sites suggests the filling of voids left by impacted species. No significant differences occurred between the east and west reference site despite frequent higher concentrations at the western reference site.

151. Throughout most of Puget Sound sedentarian polychaetes are more abundant than errantean polychaetes. High concentrations of erranteans consisting mostly of deposit feeding erranteans are found in organic-rich muds. For example, on the forset beds of the Stillaguamish River concentrations of erranteans exceed 130/0.1 m^2 compared to predisposal Elliott Bay values of 8/0.1 m^2. Richardson et al. 1976 also reported high concentrations of deposit-feeding erranteans exceeding 100/0.1 m^2 in a faunal group (A_2) associated with Columbia River deposits of wood-rich muddy sands. However, reduction in these deposit feeding erranteans occurs in the stressed habitats of Port Gardner and Everett Harbor (Harman et al. 1977b). In the deep (100 m) estuary of Port Susan predatory erranteans appear to be the only polychaetes occupying an apparent sulfite waste liquor-influenced sea bottom along with tubes of maldanid climax species.

Total mean number of errantean species

152. A number of errantean species showed similar postdisposal trends with a progressive seasonal increase in species and recovery beyond predisposal levels (Figure 29b). A marked increase occurred in the winter, suggesting the replacement of nonbenefited annuals and climax species with opportunistic species and more motile predatory errantean worms. However, the reference sites also showed a progressive increase in the number of species suggesting a regional trend of recruitment also occurring during the fall. Again corner stations showed

the highest number of species. East-west station differences did not significantly differ, despite more frequent samples with higher numbers at the western sites.

153. In Puget Sound the number of errantean species normally increase in diatom- or wood-rich accumulation sites that also have high densities of worm specimens. Examples are deltas formed near tidal channels or forset beds of river deltas. The number of errantean families decreases with increasing proximity to Everett Harbor and associated pulp mill and river-influenced habitats (Malkoff 1976). In wave-impacted habitats or river scoured sands species decline. Richardson et al. 1976 found fewer species inshore compared to offshore muddier areas. Comparisons between studies with no replicate stations are difficult because number of species in replicate samples have been combined to represent a station. In this study plots were made of mean number of species per station.

Errantean biomass

154. Biomass values were reduced immediately after disposal. A gradual recovery in the biomass occurred as was the case for densities and numbers of species (Figure 29c). However, the rate of improvement was not as complete as those for densities and number of species. The high proportion of small specimens of the first year recruitment class and absence of larger climax species produced these relatively low biomass values despite the large number of specimens present. Maximum biomass was observed at the reference sites in September. No marked difference in biomass occurred between reference sites. The biomass values over the experimental disposal site were low for Puget Sound, again indicating the small size of both the molluscs and polychaetes occupying Elliott Bay habitats. For example, in the forset beds of the Stillaguamish and Snohomish Rivers wet weight values are normally greater than 0.8 g/0.1 m^2 while typical biomass over the disposal sites was less than 0.3 g/0.1 m^2.

Changes in errantean species

155. Glycera capitata. The predatory worm G. capitata showed

a marked reduction over the central stations or disposal impact site (Figure 29d). Complete recovery occurred by the winter sampling. Maximum concentrations at the reference sites occurred in June while over the disposal site maximum values were observed in December. This seasonal difference between disposal and reference sites may indicate new sources of food items for the disposal sites such as the increase of opportunistic species that would encourage winter feeding of predatory worms. Because of their unusual increases over the disposal site and seasonal increases, they are considered benefited annuals.

156. G. capitata has an ubiquitous distribution in Puget Sound and is found in many substrates ranging from the deep soft muds of Port Susan to tidal- and wave-impacted shallow gravel sediments. This species is the dominant predatory worm in the deep habitats of central Puget Sound. However, Lie, 1968 reports G. capitata as well as Nephtys ferruginea, Malmgrenia lunualta and Lumbrineris luti as the dominant erranteans in deep habitats near Shilshole Bay. This species, along with Glycinde picta, appears to have the ability to tolerate stressed conditions compared to other errantean worms. For example, these two species dominate the near defaunated sea bottom in Port Susan which is influenced by sulfite waste liquors from local pulp mills.

157. Glycinde picta - Glycinde armigera group. The goniadid, G. picta and G. armigera are grouped together here due to the earlier grouping of these species. However, G. armigera was the most frequent species found. No specimens were observed over the disposal site for 3 months after disposal (Figure 30a). Recruitment began in late summer and increased in concentration by late fall beyond predisposal levels. No significant difference occurred between the reference sites; an increase in concentration was observed in the September sampling. The increase over the disposal site during December, despite the winter decline at the reference site suggests favorable postdisposal conditions at the disposal site. Because of its unusual increases over the disposal site and seasonal increases this species was classified as a benefited annual. Goniadids are regarded as motile jawed carnivores by Fauchald

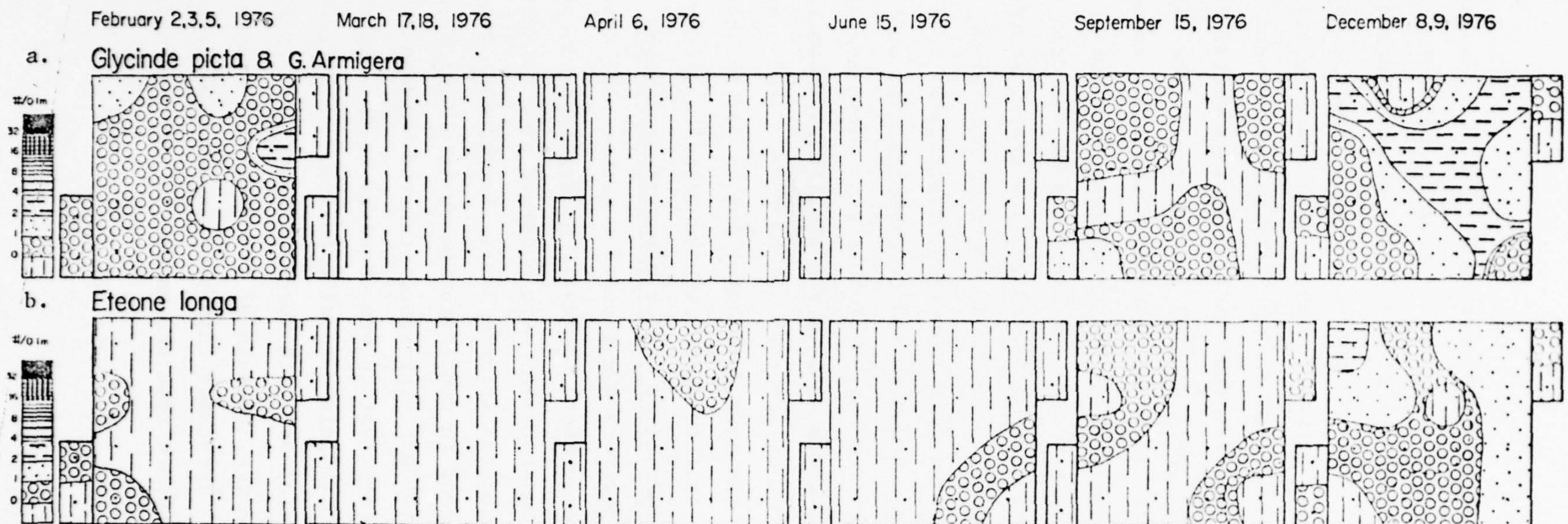


Figure 30 a and b. Temporal and spatial changes in concentrations (numbers per $0.1 m^2$) of G. picta, G. armigera and E. longa.

and Jumars (in press).

158. This species group dominates the nearshore river-influenced habitats of Elliott Bay, Shilshole Bay, and Port Susan. When most other species decline in numbers in stress habitats this species group persists along with G. capitata suggesting their high degree of stress tolerance. Lie 1968 reported G. picta abundantly in his station 4 at the entrance to the river influenced bay, Miller Bay, associated with other species commonly found in shoreline study area: Nephtys ferruginea Platynereis bicanaliculata, Prionospio malmgreni and unknown capitellids. In this same study G. armigera was found in deep stations associated with G. capitata, Nephtys ferruginea, Lumbrineris luti, capitellids, pectinarians, and P. malmgreni. Compared to other errantean worms, G. armigera had a relatively high frequency of occurrence in the gut of fish.

159. Eteone longa. E. longa (Phyllodocidae) rarely occurred at either reference or disposal sites prior to disposal (Figure 30b). Recolonization began over the disposal site in late summer and attained a maximum concentration by the December sampling. The relatively high numbers on the east side along with Amphicteis scaphobranchiata suggest the influence of the Duwamish River. No significant difference in concentration occurred between the east-west reference sites. However, the greater frequency of E. longa outside the direct impact area suggests its competitive exclusion from this area by abundant selective opportunistic species. Rare occurrences in predisposal samples and a subsequent post-disposal increase over the disposal grid area justifies a nonselective opportunistic species classification.

160. E. longa is found frequently on the uppermost portions of deltas or in tideflat habitats. Its association with A. scaphobranchiata in nearshore muds adjacent to the mouth of the Stillaguamish River suggests a euryhaline indicator species. This species was reported by Saila et al. 1971 as a possibel opportunistic species occupying a disposal site in Rhoad Island Sound. Unknown Eteone sp. were described as stress tolerant species in an Oregon estuary disposal study by Parr et al. 1974.

161. Nephtys ferruginea. N. ferruginea (Nephtyidae) was widely distributed prior to disposal (Figure 31a). After disposal reduction occurred primarily over the direct impact stations. Recovery began at the corner stations during June and had exceeded beyond predisposal values by the September and December sampling periods. At the disposal site highest concentrations were observed during both summer and winter sampling periods. The western reference site had higher concentrations compared to the eastern site. Unlike the disposal site, densities at the reference site declined during the winter. Thus, the progressive seasonal increase over the disposal site suggests a benefited effect of the disposal impact. Perhaps the increase of N. ferruginea is a response to greater available food or decreased predation. Most predatory worm species in this study increased in September and December. Its June increase corresponds to the time when most deposit feeding worms increased in concentration suggesting a deposit feeding mode. These species are considered by Lie 1968 and Nichols 1970 deposit feeders based on their intestinal contents. However, Fauchald and Jumars (in press) indicate a motile carnivorous feeding mode.

162. N. ferruginea is found in many substrates and has an ubiquitous distribution throughout Puget Sound. Lie 1968 reported high concentrations in his shallow stations 3 and 4 yet the species also dominated his deep station 2. The authors have also observed this species dominating the polychaete fauna and having high concentrations in the shallow estuaries of Port Madison, Dyes Inlet, Liberty Bay, and Port Orchard. In the shallow habitats it is frequently associated with Prionospio (steenstrupi) malmgreni. Data of Lie (1968) suggests lower concentrations in southern Puget Sound as compared to central Puget Sound. Its reduced numbers in the estuaries adjacent to Everett as well as those of southern Puget Sound suggests its avoidance of river-influenced habitats.

163. Lumbrineris luti. L. luti (Lumbrineridae) was found in most samples prior to disposal (Figure 31b). Little or no recovery occurred over the direct impact area or central stations (7 and 11).

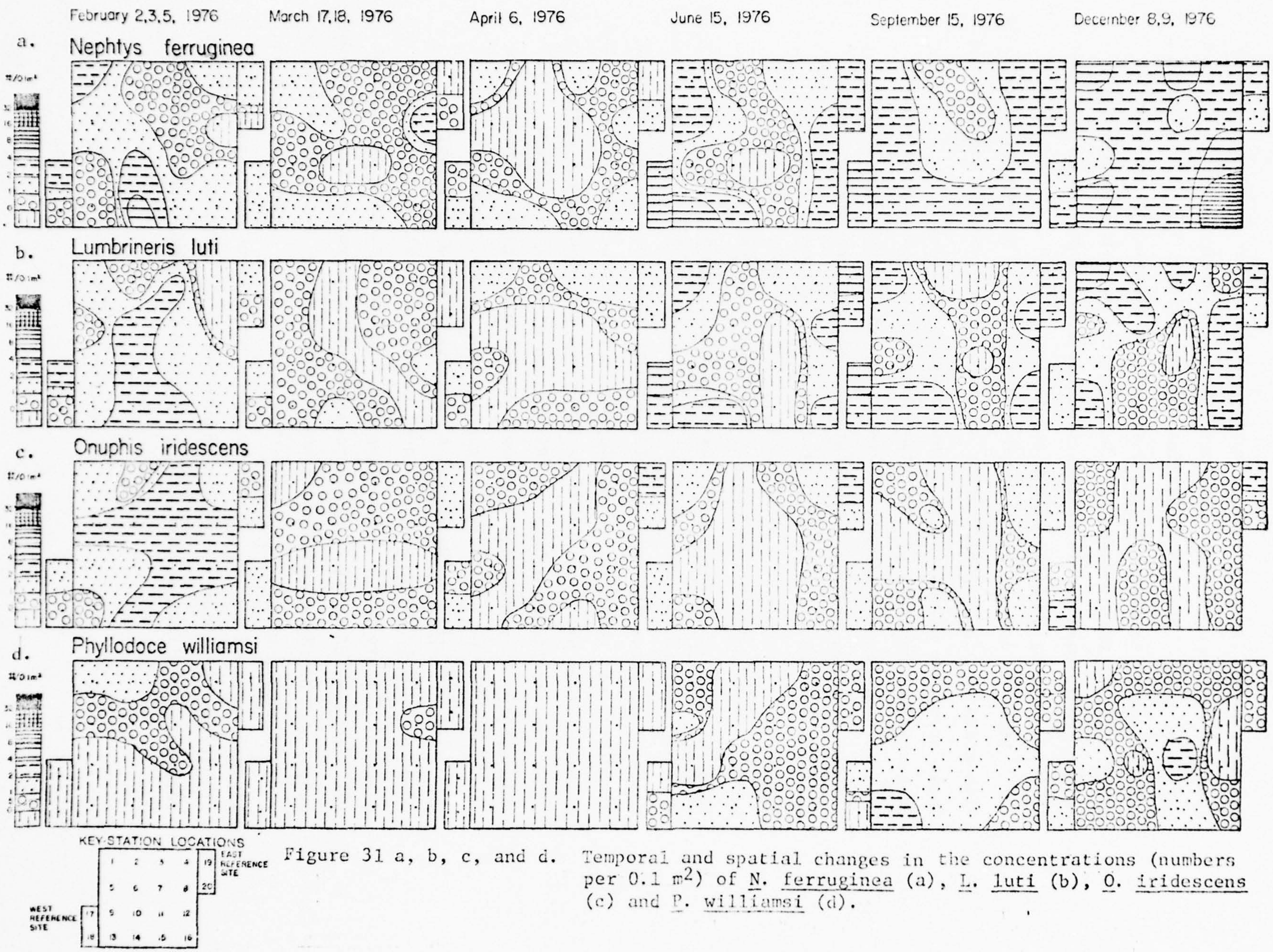


Figure 31 a, b, c, and d. Temporal and spatial changes in the concentrations (numbers per 0.1 m^2) of N. ferruginea (a), L. luti (b), O. iridescens (c) and P. williamsi (d).

Recovery began first in June primarily at the corner stations. During June and September maximum concentrations were observed at the western reference site. A seasonal decline was indicated. The poor rate of recovery over the direct impact site and its seasonal recruitment would classify this species as a nonbenefited annual. Its recovery beyond predisposal levels at the corner stations suggests its occupancy of voids left by impacted climax species.

164. In central Puget Sound L. luti is most frequently associated with areas of high organic matter or areas of wood debris accumulation. These areas are normally high in mud contents typical of near-river habitats or protective embayments such as Dyes Inlet, Liberty Bay, Sinclair Inlet, Shilshole Bay and Elliott Bay. They decline in concentration in more wave-influenced or tidally impacted habitats or habitats more distant from river influences. L. luti increases quite markedly between the 1st and 14 Avenue Bridges within the Duwamish River channel. In Port Susan this species was found abundantly on the foreslopes of the Stillaguamish River but markedly reduced in concentration on the Snohomish Delta located adjacent to the deep water diffusor of sulfite waste liquors. L. luti is found abundantly off the coast of Washington in the northerly portions of the midshelf areas where the Columbia River mud and wood debris appear to be preferentially deposited (Richardson et al. 1977, Harman, 1973). This species is considered a deposit feeder although lumbrinerids can be carnivorous or herbivorous (Fauchald and Jumars, in press).

165. Onuphis iridescens. A relatively large tube-dwelling polychaete O. iridescens (Onuphidae) was found in all stations prior to disposal (Figure 31c). After disposal a marked reduction occurred at all stations and no significant recovery was apparent during postdisposal sampling. No significant differences were observed between the east and west reference sites. Mean densities were highest during the June and September sampling. Because of the poor improvement and lack of significant seasonal changes in concentration or biomass, this species is considered a climax species. Most onuphids are considered by Fauchald

and Jumars (in press) to be omnivorous scavengers.

166. This species in Puget Sound appears to be most frequent in sandy, muddy habitats. In the estuaries adjacent to Everett this speices was most abundant in deep habitats close to areas where sediment and organic debris are displaced from shallow habitats into the deeper habitats.

167. Phyllodoce williamsi. P. williamsi (Phyllodocidae) was mainly distributed in low concentrations in the deeper stations over the disposal site (Figure 31b). After disposal, recovery was first observed in June, and maximum values were obtained during the month of September. The reference stations showed a similar trend. Over the disposal site the summer increase appeared mostly in the shallow stations suggesting possible nearshore river influence. Unusually high concentrations appeared over the direct impact station 7. The response of this species to the disposal impact appears to classify it as a benefited annual. Fauchald and Jumars (in press) describe most phyllodocids as free living carnivores with unarmored eversible proboscis.

168. In Puget Sound this species rarely attains high concentrations. In this study of central Puget Sound and estuaries adjacent to Everett, this speices' distribution is highly sporadic. Lie, 1968, reports several rare Phyllodoce species (P. groenlandica, P. williamsi, P. costaria, P. polynoidae, P. multiserata, and P. metapalpa). The other Phyllodoce speices reported in this study is P. groenlandica.

Other errantean species

169. Nereids found in the Duwamish River, Nereis procera and those typifying shallow habitats outside Elliott Bay, Platynereis bicaniculata were rarely observed at any of the stations. Pholoe minuta, a sigalionid, exhibited a variable distribution pattern with low densities throughout the study area. Unidentified polynoids similar to Harmothe imbricata and Malmgrenia lunulata were also rarely observed despite the common occurrence in deep habitats near Shilshole Bay (Lie 1968). The syllid, Syllis harti was most frequent at the reference site and station 16 compared to most other disposal stations. The

polydontid, Peisidice aspera was rare in this study and is more frequent in southern Puget Sound (Lie 1968) and especially in tidal channels. Taxonomic identifications appeared to be most difficult within the lumbrineris, phyllodocids, goniadids, and polynoids groups. Other species observed were the phyllodocid Eulalia leuicornuta, the onuphid Diapatra ornatus, the lumbrinerids Lumbrineris bicirrata and Ninoe gemmea and the glycerids Glycera americana and G. tesselata.

Summary of the relative degree of impact.

170. Three approaches were used to evaluate the relative degree of damage from dredged material disposal on the polychaete worms: (a) evaluate the areal distribution patterns and their relative concentrations and assume that stations with the lowest values represent the disposal impact area, (b) compare the changes in concentrations or biomass relative to predisposal values and assume that stations having a maximum decrease in value are associated with the direct impact site, and (c) calculate and plot the biomass per individual and assume that small values correspond to periods of repopulating juveniles or large organisms capable of resurfacing through disposed material.

171. Impact on temporal and spatial distribution. After disposal the entire disposal grid was influenced by the dredged material while the reference sites were unaffected. Both sedentarian and errantian worms showed a maximum decrease in densities, species richness, and biomass over stations 11, 7, and 10. Least affected were the corner stations 1, 4, 16, and 13. Side stations that were moderately affected were 14, 9, 12, and 2 while 3, 5, 8, and 15 were relatively less affected.

172. Species that were absent or rare before disposal but increased markedly over the disposal site were considered opportunistic speices. Selective opportunists that preferentially increased over the direct impact site during the summer were deposit-feeding polychaetes, the tube dweller Polydora uncata and Ammotrypane aulogaster. Nonselective opportunists occupied the entire disposal gird area mainly during the fall, especially on the more river-influenced eastern disposal grid

margin. These species were the sedentarians, Amphicteis scaphobranchiata, Aricidea longicornuta, and Trochochaeta multisetosa and the errantian Eteone longa. Most of these species are found in shallow, river-influenced habitats in Puget Sound.

173. Some occupants found during the predisposal period showed seasonal increases in concentration and increased beyond predisposal concentration after disposal - the benefited annuals. Most of the benefited annuals were predatory worms such as Glycera capitata, Glycinde armigera, Phyllodoce williamsi, and Nephtys ferruginea (latter two species might be deposit feeders) and the deposit-feeding spionid Prionospio malmgreni. These species show maximum concentrations over the disposal grid area during the winter, despite declines at the reference sites.

174. Nonbenefited annuals are those that showed seasonal changes at reference stations and marginal grid stations but no improvement over the direct impact site. These species were deposit-feeding sedentarians Heteromastus filobranchus, Euclymene zonalis and the errantian Lumbrineris luti. These species also appear to be most sensitive to stress conditions in other marine habitats. The use of the term nonbenefited annuals is in part misleading since these species increased seasonally at the corner stations, especially the tube-dweller Euclymene zonalis. Their increase is probably a response to niches left unoccupied by impacted climax species.

175. Larger worms that occupied large tubes did not show seasonal trends at the reference sites or improvements at the disposal site. These species were regarded as climax speices since they would probably require more time to establish themselves in these marine habitats. Most of the species were sedentarian tube dwellers such as Praxilella gracilis, P. affinis, Asychis similis, Pectinaria californiensis, Laonice cirrata, and the errantian Onuphis iridescens.

176. Recognition of the maximum disposal impact area was best demonstrated by: (a) selective opportunistic species based on their marked increase over the impact areas, and (b) nonbenefited annuals that

decline over this direct impact site. Thus, it appears that selective op ortunistic species occupied the niches left by nonbenefited annuals. On the other hand, benefited annuals and nonselective opportunistic species appeared to reoccupy the voids left by the decline or absence of the climax species.

177. Degree of change from predisposal values. Areal plots of differences between sampling periods and their predisposal values show lesser concentrations (negative values) or higher concentrations (positive values) than predisposal values (Figure 32a to 32d). Increased values indicate improvements caused by opportunistic or benefited annuals as well as seasonal changes. Negative values indicate losses of organisms caused by the disposal impact or seasonal declines. These methods did not accurately define the impact site since predisposal values were not obtained during the season when concentrations were at a minimal. Seasonal lows were observed in March and not in February, the time of predisposal sampling.

178. The change in total sedentarian specimens (Figure 32a) exhibited values above predisposal concentrations during the last three sampling periods over most of the disposal grid area. However, the small size of these specimens is suggested by the biomass values which to date have not completely recovered (Figure 32b). Although improvements occurred at the reference sites they were not of the same magnitude. In contrast, the errantian species consisted mostly of predatory worms or benefited annuals which showed post disposal improvements in the late summer and winter (Figure 33c). Again the small size is suggested by the lower recovery of the total errantian biomass compared to their concentrations (Figure 33d). At the reference site maximum improvements were observed during the September sampling period, although some improvements occurred during the December sampling.

179. Degree of weight change per specimen. A mature population having few juveniles should have a higher biomass per specimen comapred to a youthful population. After disposal most specimens that survived by resurfacing through the disposal sediment cover should be large and

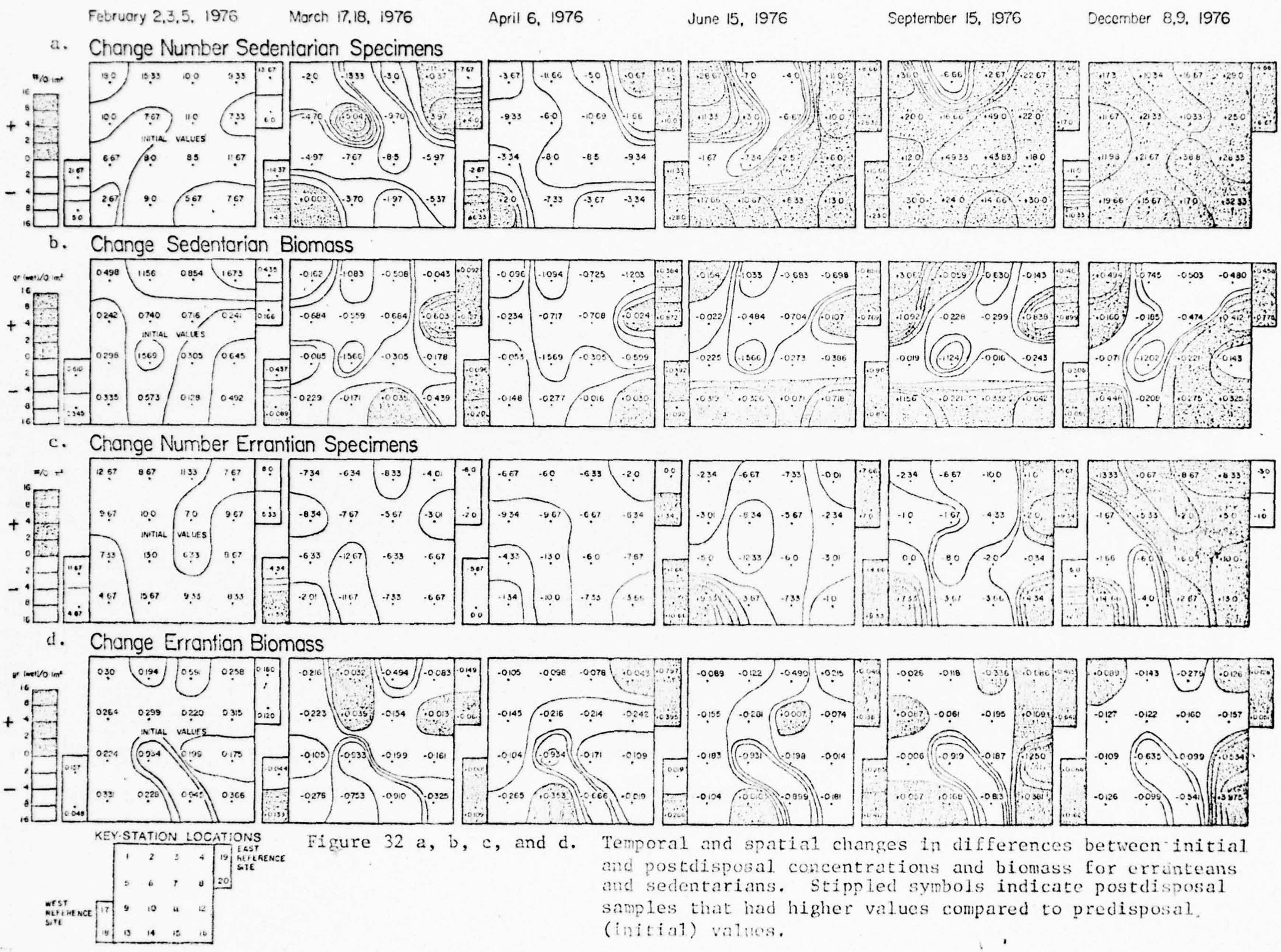


Figure 32 a, b, c, and d. Temporal and spatial changes in differences between initial and postdisposal concentrations and biomass for erranteans and sedentarians. Stippled symbols indicate postdisposal samples that had higher values compared to predisposal (initial) values.

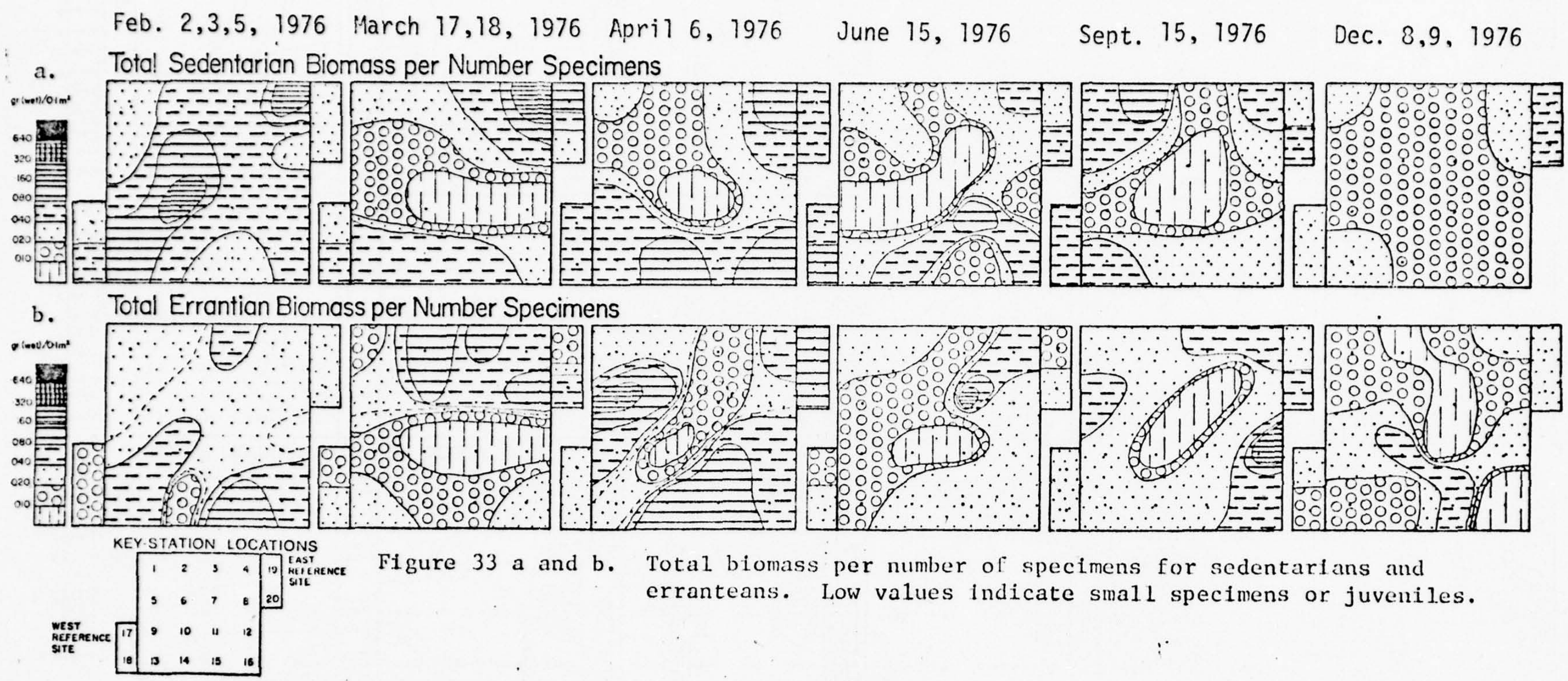


Figure 33 a and b. Total biomass per number of specimens for sedentarians and erranteans. Low values indicate small specimens or juveniles.

plots of biomass per specimen value should be high. In contrast if juveniles readily occupy this site or are displaced into the disposal area plots of biomass per specimen value should be low.

180. In general, the values prior to disposal appear to be larger than after disposal despite a high degree of variability in the data (Figure 33a and b). Over the impact site low values were consistently found suggesting rapid occupancy by small specimens. The low value found immediately after disposal were not caused by seasonal recruitment since densities did not increase until 3 months after disposal. Low values may have been caused by turbidity currents or suspension of organisms caused by the disposal impact. The larger vaues at the corners and side stations suggest a more mature population compared to the central stations.

181. Too much variability existed in the data that summarize the total sedentarina and errantian biomass to be useful. The major problem with this approach is the inclusion of identifiable partial specimens which would cause smaller values compared to whole specimens. Another problem exists since all species were grouped together. Large specimens would overly bias the data. It is recommended that the computer analysis evaluate weights per specimen at the species level.

Spatial and Temporal Changes in other Macrofaunal Organisms

Other worms

182. The nemertean Cerebratula sp. was arbitrarily separated into large (lengths greater than 40 mm) and smaller juvenile specimens (Figure 34a and b). Large specimens of Cerebratula sp. did not recover until the winter sampling. Juveniles were present immediately after disposal, primarily at the corner and side stations. No seasonal trends were observed at either reference site although the west reference site appeared to have consistently more specimens present. In central Puget Sound these species are more typical of the muddier habitats, especially near rivers.

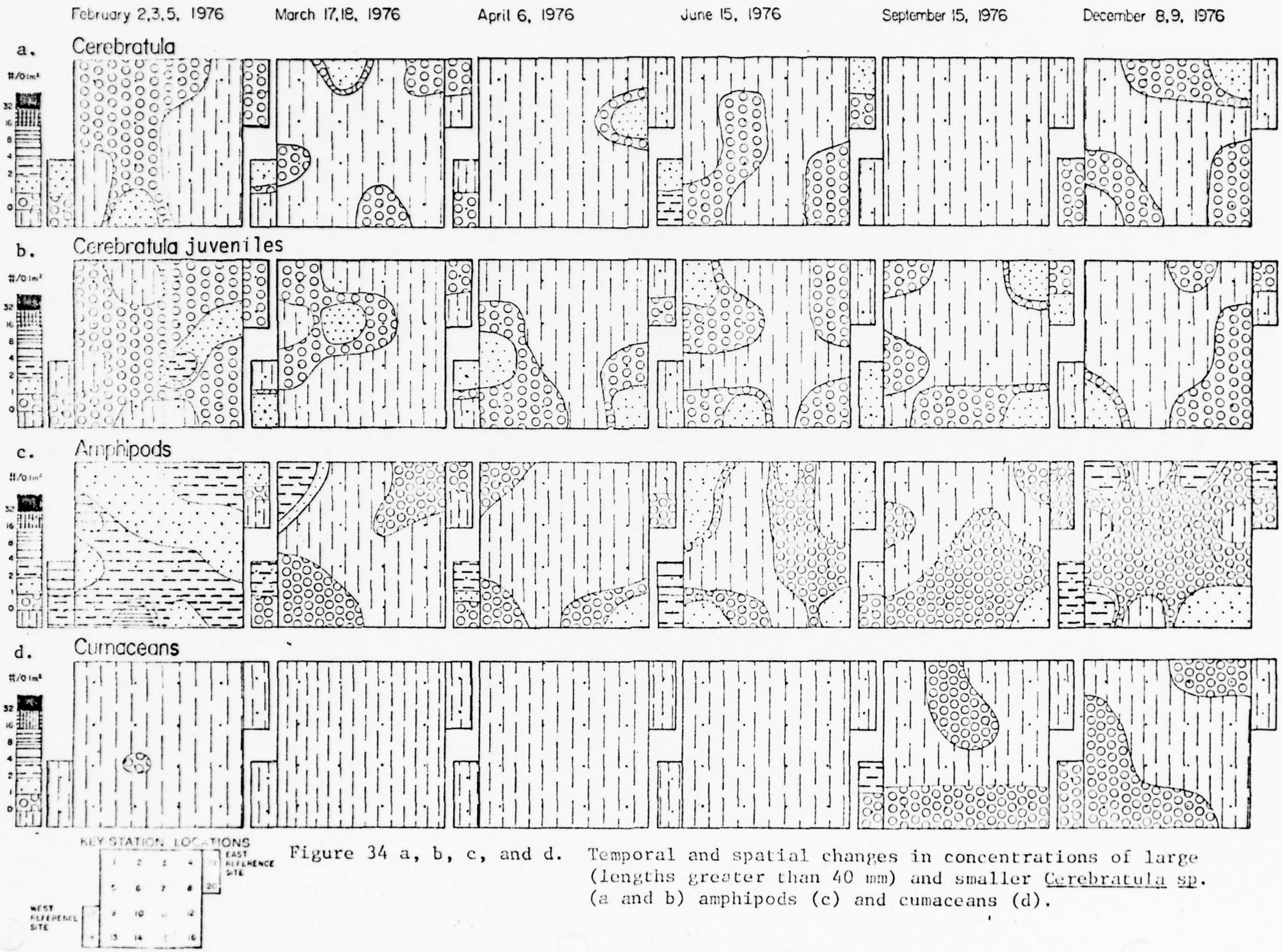


Figure 34 a, b, c, and d. Temporal and spatial changes in concentrations of large (lengths greater than 40 mm) and smaller *Cerebratula* sp. (a and b) amphipods (c) and cumaceans (d).

183. Unidentified sipunculids were found over both disposal and reference sites. Their distribution, like the nemerteans was too sporadic and uncommon to show any seasonal or regional trends.

Crustaceans

184. Suprisingly amphipods did not recover to predisposal levels during the postdisposal period (Figure 34c). The greatest rate or recovery over the disposal grid occurred during the winter. Amphipods were more dense at the west reference sites having maximum concentrations during the summer months. In central Puget Sound amphipods were most abundant in areas of strong currents or turbulent water habitats such as those found in tidal channels or wave impacted shorelines. Lie 1968 in his sutdy reports Heterophoxus oculatus and Paraphoxus oculatus as the most frequent amphipods in the deep basin station (Station 2) of central Puget Sound.

185. Unidentified cumaceans were rare throughout the sampling area (Figure 34d). Like the amphipods, the greatest improvements occurred at the corner stations during the September and December sampling periods. Lie 1968 reports in his deep station (2) Eudorella pacifica as the most frequent species. Cumaceans were the major faunal constituents in the nearshore communities off the Columbia River (Richardson et al 1976).

186. Other crustaceans such as ostracods and tanadaceans were rarely sampled at either the disposal site or reference stations. There was some suggestion that the west reference site contained more of these organisms than either the disposal or east reference stations. Stomach analysis of flatfish from the west reference site had more frequent occurrences of these small crustaceans. Few crabs were sampled, but otter trawls collected Cancer productus frequently. Occasional shrimp were observed in the grab samples but not in sufficient numbers to decipher changes resulting from disposal activity. Frequent shrimp observed in the otther trawl NMFS were Pandalus danai, P. borealis and P. platyceros.

Other macrofaunal organisms

187. Although the holothuroid Molpaldia intermedia is frequently

found in the deeper areas of Puget Sound, they were primarily sampled at the intermediate depths of Elliott Bay. Brittle stars were also rarely sampled, despite their frequent occurrence outside Elliott Bay and in the shallow estuaries of central Puget Sound (faunal group R-4).

Spatial and Temporal Changes in Empty Tubes

188. Although amphipods such as *Ampelisca* sp. and tanadaceans such as *Leptochelia savigni* build tubes, the tube types in Elliott Bay were polychaete worms. The change in worm tube concentration provides a long-term assessment of the recolonization by worms subject to predation. Predation of worms would have the tendency to lessen seasonal increases in living worm densities, yet observations of worm tubes may suggest seasonal changes by increases that may occur in empty worm tubes left behind in the bottom sediment. Thus differences between annuals and climax speices, or those reproducing at lower rates can be further assessed using worm tube information. Woodin 1974 demonstrates the competitive role that worm tubes have in limiting space for other motile organisms such as deposit-feeding polychaetes. In this study the larger mud and sand tubes were reduced over the disposal site and were replaced by smaller worm tubes of more opportunistic or annual species.

Total sand tubes

189. Sand tubes dominated most of the empty tubes others found consisted of mud, chiton, mucous or parchment material. A marked decline over the central stations occurred in the worm tubes after disposal and no recovery was discernable during the first two sampling periods (Figure 35a). Increases in densities occurred during June and, especially in September when maximum numbers were observed at the corner stations and reference sites. The western reference site had higher numbers of sand tubes compared to the eastern site. Higher values were observed at both the corner and reference site stations compared to their predisposal values. The increased number of sand tubes over the disposal

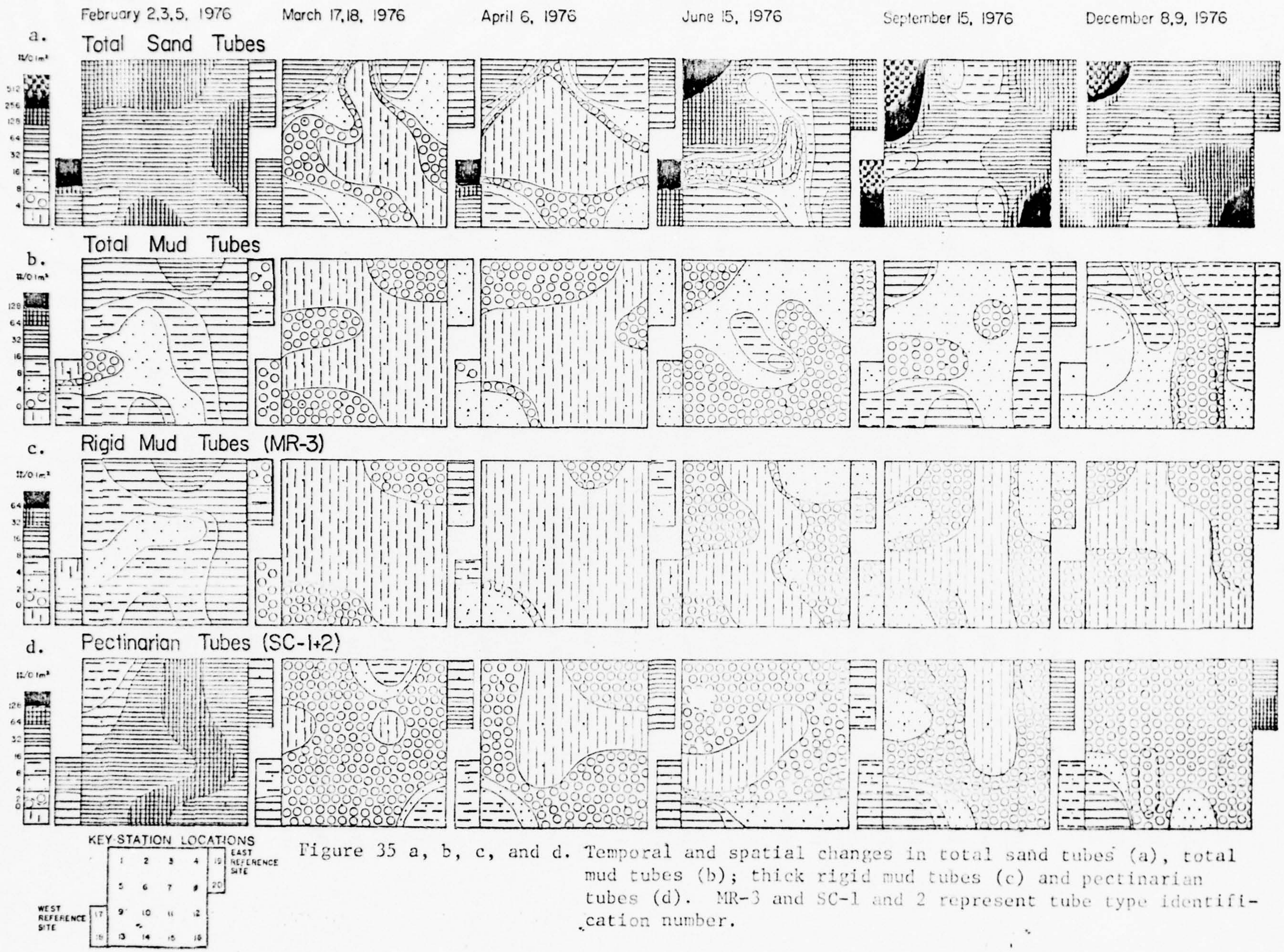


Figure 35 a, b, c, and d. Temporal and spatial changes in total sand tubes (a), total mud tubes (b); thick rigid mud tubes (c) and pectinarian tubes (d). MR-3 and SC-1 and 2 represent tube type identification number.

site was mainly attributed to the additions of the opportunistic tube builder Polydora uncata and the nonbenefited annual Euclymene zonalis. Reduction in the sand tubes was especially prominent in tubes SR1 and 10 and pectinarians and those belonging to Onuphis iridescens (SR 4).

Total mud tubes

190. Although mud tubes were not as frequent as sand tubes they also showed a marked reduction following disposal (Figure 35b). Recovery was first indicated in June especially over the impact site. The decline in mud tubes was especially prominent in such large madanids as Praxilella gracilis, P. affinis, and Asychis similis (Figure 35c). These climax species mud tubes, showed little recovery after disposal. No seasonal changes were observed at the reference site although they appeared to prefer the eastern reference site. Either the presence of coarse wood debris or more likely, their low reproductive rate may account for their poor recovery rate.

191. A flexiable mud tube (MF-9) and a mucous tube (MM-4) probably belong to the nonselective opportunistic speices Amphicteis scaphobranchiata. Plots of MM4 show their absence prior to disposal, increase in numbers in the June and September sampling periods, and declines in December. Other mud tubes were not plotted because of their low concentrations and seemingly sporadic distribution.

Change in sand tube types

192. Conical-shaped, brittle sand tubes probably belonging to Pectinaria californiensis showed little improvement after disposal (Figure 35d). The greatest rate of improvement occurred during the winter sampling although the corner stations began to improve during the June sampling. The recovery of these tubes was greater than that indicated by their living counterparts. Because of this relatively high recovery rate, this species might be considered a nonbenefited annual, instead of a climax species. Pectinarian tubes seem to be more frequent in the eastern reference sites, an area with relatively low amounts of wood debris but having a greater influence of river sedimentation and subsequent high mud content compared to the western reference site.

193. Small brittle, rigid, cylindrical sand tubes (SR-1 and SR-10) did not recover (Figure 36a and b). It is possible that these tubes are in fact the foraminifera, Bathysiphon sp. despite the extremely rare presence of a syllid polychaete occupant. These tubes were abundant at the intermediate depths in the current-swept sand areas outside Elliott Bay and were found associated with Nemocardium centifilosum and Nuculana minuta (D-6 faunal group). Like the pelecypods, the tubes that did not recover were typical of species more frequently found outside Elliott Bay or those regarded as expatriated climax species.

194. A small- to medium-sized rigid sand tube (SR-7), belonging to Euclymene zonalis, showed a reduction in number after disposal over the impact site (Figure 36c). However, these tubes increased in numbers at the corner and side stations during the summer sampling like the living counterparts, suggesting occupancy of voids left by impacted species. At the reference sites a similar summer increase was observed, and the western reference site appeared to be preferred.

195. A large- to medium-sized rigid sand tube (SR-4) probably belonging to Onuphis iridescens, showed no recovery over the disposal grid (Figure 36d). No seasonal trends were observed and no preference for the east reference site was noted, a trend typical of climax species.

196. The most significant increase occurred in the rigid U-shaped brittle tube formed by the opportunistic species Polydora uncata. Tubes began to appear in June and have since altered the surficial portion of the sediment by their presence. Their concentration was highest over the central stations or direct impact site. Tubes were rare or absent at the reference sites. These tubes have not been reported from earlier studies of central Pcget Sound or Elliott Bay. The maximum numbers were observed in September and December. Other sand tubes were not plotted due to their low concentrations and seemingly sporadic distribution.

Spatial and Temporal Changes in Stomach Contents of Selected Fish

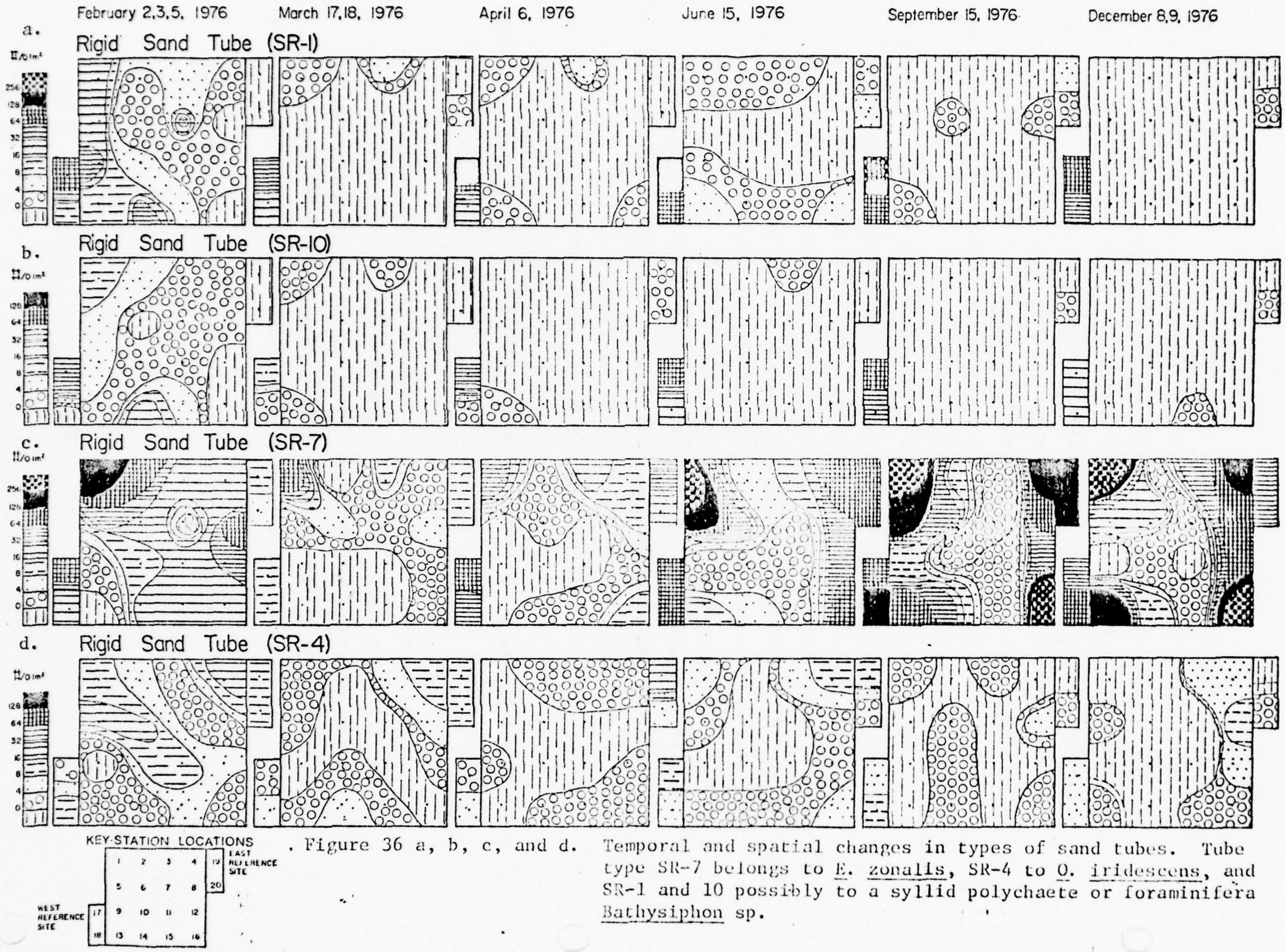


Figure 36 a, b, c, and d. Temporal and spatial changes in types of sand tubes. Tube type SR-7 belongs to E. zonalis, SR-4 to O. iridescens, and SR-1 and 10 possibly to a syllid polychaete or foraminifera Bathysiphon sp.

Temporal changes in stomach contents

197. Because of the lack of consistent numbers of fish specimens collected between sampling periods and between species, only suggested trends can be discussed since statistical assessment is not possible.

198. During the predisposal period shiner perch, Pacific cod, Pacific hake, Dover sole, English sole, petrale, flathead, rock sole, copper rockfish, midshipmen, and black tipped poacher were sampled for stomach content. The dominant food item in most fish guts during the winter sampling was amphipods with lesser amounts of mysids, shrimp, and ostracods. During the February sampling flatfish except for the rex sole, had empty stomachs. During the next three sampling periods after diposal only flatfish and copper rockfish were collected. Dominant food items in the stomachs were Macoma carlottensis followed by Axinopsida serricata and various polychaetes, shrimp, and ostracods (Table 5). The dover sole had greater amounts of food items followed by flathead and slender sole. Fewer specimens in flatfish stomachs were collected from the eastern reference site compared to the more frequent specimens found at the western reference site and the disposal site.

199. Selective predation by the dover sole occurred (Figure 37) Selectivity was indicated by 4:1 stomach ratios of M. carlottensis to A. serricata compared to the opposite ratios found in sediment on the sea bottoms. During the winter, occasional fish had extremely high amounts of the calcareous tube of the polychaete Serpula. A high proportion of predatory errantian polychaetes such as Glycera capitata and Glycinde picta was found despite the dominance of tube dwelling and deposit-feeding sedentarian polychaetes. The effect of the disposal activity was indicated by the selective feeding of the dover sole on the opportunistic worm Ammotrypane aulogaster. During the summer sampling these species became the most dominant food item for dover sole over both the disposal site and eastern reference site. The high number found at the eastern reference site is consistent with regional distribution studies indicating their preference for more river-influenced habitats. Worm tubes of P. uncata were rarely observed in the stomach contents

Table 5

Seasonal Changes in Stomach Contents of Dover Sole

	Sampling Times							
	Predisposal				10 Days			
	Sites							
	Dis-posal	East	West	Total	Dis-posal	East	West	Total
Number of Fish analyzed	0	1	1	2	3	5	8	16
Food Items								
Amphipods	ND**	0	0	0	10	6	12	28
Ostracods	ND	0	0	0	0	0	2	2
Tanadaceans	ND	0	0	0	0	0	0	0
Shrimp	ND	0	0	0	0	0	0	0
Crab	ND	0	0	0	0	0	0	0
M.carlottensis	ND	0	0	0	2	11	36	49
A.serricata	ND	0	0	0	0	7	10	17
Other pelecypods	ND	0	0	0	3	0	2	5
Gastropods	ND	0	0	0	0	1	1	2
Sedentarian Polychaetes	ND	0	3	3	0	3	5	8
Errantean Polychaetes	ND	0	5	5	0	5	4	9
Worm Tubes	ND	0	0	0	4	0	2	6
TOTAL				8				126

(Continued)

** No Data

Table 5

Continued

	Sampling Times							
	1 month*				3 months*			
	Sites							
	Dis-posal	East	West	Total	Dis-posal	East	West	Total
Number of Fish Analyzed	3	3	3	9	6	3	12	21
Food Items								
Amphipods	6	1	4	11	0	1	22	23
Ostracods	0	0	3	3	0	0	20	20
Tanadaceans	0	0	2	2	0	0	3	3
Shrimp	0	0	0	0	0	1	0	1
Crab	0	0	3	3	0	3	5	8
M.carlottensis	1	0	29	30	304	28	415	747
A.serricata	12	0	16	28	16	13	35	64
Other pelecypods	3	0	1	4	1	2	5	8
Gastropods	1	0	1	2	0	0	1	1
Sedentarian Polychaetes	11	40	3	54	0	0	11	11
Errantean Polychaetes	8	10	0	18	0	2	5	7
Worm Tubes	0	0	0		2	0	0	2
TOTAL				155				895

(Continued)

* Probable error in recorded fish number.

Table 5

Concluded

	Sampling Time											
	6 month				9 month				Total			
	Sites											
	Dis-posal	East	West	Total	Dis-posal	East	West	Total	Dis-posal	East	West	Total
Number of Fish Analyzed	16	10	3	29	1	10	16	27	29	32	43	104
Food Items												
Amphipods	19	7	0	26	ND**	13	13	26	32	28	51	114
Ostracods	1	8	14	23	ND	2	5	7	1	10	44	55
Tanadaceans	0	0	0	0	ND	0	0	0	0	0	5	5
Shrimp	0	0	1	1	ND	0	1	1	0	1	2	3
Crab	1	2	2	5	ND	3	0	3	1	8	10	19
M.carlottensis	70	13	4	87	ND	35	0	35	377	87	484	948
A.serricata	67	5	21	93	ND	2	0	2	95	27	82	204
Other Pelecypods	3	1	6	10	ND	1	2	3	10	4	16	30
Gastropods	0	0	1	1	ND	0	0	0	1	1	4	6
Sedentarian Polychaetes	1009	155	4	1168	ND	2	4	6	1020	200	30	1250
Errantean Polychaetes	12	2	0	14	ND	3	5	8	20	22	19	61
Worm Tubes	0	0	0	0	ND	0	3	3	6	0	5	11
TOTAL				1428				94				2706

**No Data

SEASONAL CHANGES IN STOMACH CONTENTS OF DOVER SOLE

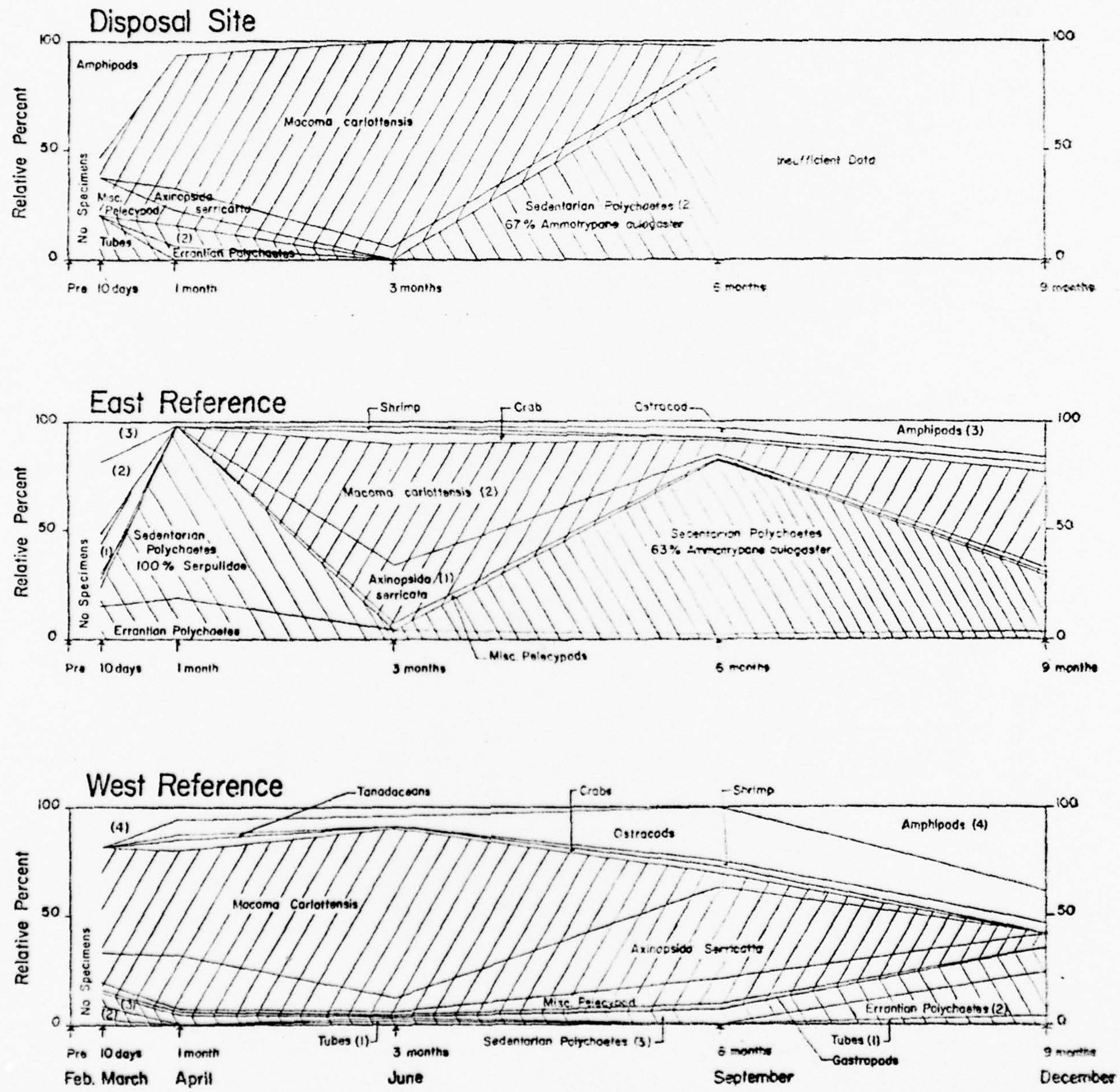


Figure 37. Seasonal changes in the stomach contents of dover sole at the east and west reference sites and over the disposal site. Although the river influenced eastern site and disposal site had high occurrences of the selective opportunists A. aulogaster, concentrations were highest over the disposal site indicating selective feeding by the dover sole.

despite their abundance at the disposal site. The decline of these worm during the winter can probably be attributed to predation by the associated winter increase in predatory worms. The greater amounts of ostracods and tanadaceans in fish guts at the western reference site are consistent with their greater occurrence in bottom sediment on the western side of the bay.

PART V: DISCUSSION

Impact of Disposal on the Macrofauna

Areal extent of disposal impact

200. In this study the mean density of all organism groups were reduced to 21 percent of initial values over an area of 1,445,200 sq ft; biomass was immediately reduced to 25 percent of predisposal values. Over the direct impact stations (7, 10 and 11) samples declined to less than 10 percent of their initial values in an area of 270,000 sq ft having a maximum disposal mound depth of 9 ft. The entire disposal grid area substrates were changed from equal amounts of rock and wood-plant debris present in washed sediment residues to those having greater than 90 percent wood-plant debris.

201. Cronin 1970 showed a reduction of 71 percent in macrofaunal densities and 65 percent in biomass over 3,000 sq ft area with 1 ft of disposal deposit. Saila et al. 1972 observed reduction in densities in an area with a 1-mile diam and having a disposal mound 16 to 18 ft high at the center. In his study species were transported into the disposal area from the dredged site unlike this study. Richardson et al. 1977 reported no dredge site transported species and indicated declines in density and biomass over a 2000 ft radius with disposal cover as high as 4 ft.

202. In this study the exact areal extent of the disposal material could not be determined since the sampling grid at the disposal site was not large enough. The loss of disposal material due to erosion by currents or downslope movement of disposal material was not discernable. In a tidal scoured channel in Puget Sound (Dana Passage) one third of the disposed material was believed to have been dispersed by bottom currents that exceeded 27 cps (Sternberg and Collias 1975). Dispersal by erosion in Elliott Bay probably would not occur because of the absence of strong currents. Downslope movement may be important especially at the eastern margin of the disposal grid where steep gradients occur. Mauer et al. 1974 believes downslope movement of disposal material was important in the loss of 62.5 percent of the dredged disposal material.

Identification of disposal impact on macrofauna

203. All the disposal grid stations were impacted by the disposed dredge material as indicated by changes in sediment characteristics and declines in macrofauna density, species richness, and biomass. Of the three classical approaches used in this study to assess the relative damage caused by impact of disposed material, the plots of concentration, species richness, and biomass best reflected the severity of impact. This study and the one by Mauer et al. 1974 found that biomass did not provide as definitive a picture of the relative impact of disposal material as did density. Other methods, depicting differences between predisposal and postdisposal values and those showing areal distribution changes in weight per specimen or percent living specimens did not accurately detect the impact site.

Nature recolonizers

204. Opportunistic species that recolonized the direct impact area were deposit-feeding polychaetes, a tube dweller Polydora uncata, and a motile form Ammotrypane aulogaster. Over the entire disposal grid opportunistic species that were rare or absent prior to disposal and that normally occupied shallow nearshore river influenced habitats were uniformly dispersed over the disposal site (eg. Trichochaeta multisetosa, Aricidea longicornuta and Eteone longa). No motile opportunistic forms, such as amphipods, cumaceans, or tanadaceans, recovered rapidly over the site. However, concurrent fish studies indicated rapid reoccupation of fish and shrimp.

205. Nonbenefited annuals or those species which showed seasonal increases but little recovery over the direct impact site were the polychaetes Euclymene zonalis, Heteromastus filobranchus, and Lumbrineris luti and the clams Axinopsida serricata and Nucula tenuis. Benefited annuals or those species showing seasonal increases in concentrations in December over the disposal site, despite their declines at the reference sites, consisted mainly of predatory worms (e.g. Glycera capitata, Glycinde armigera, Nephtys ferruginea, Phyllodoce williamsi, the deposit

feeding worm Prionospio malmgreni, and possibly the pelecypods Macoma alaskana and M. carlottensis). The latter pelecypods appear to show a lesser degree of damage compared to Axinopsida serricata which shows broadened area of decline over the impact site during the 9-month sampling period. This small clam decline is further suggested by the increased ratio between A. serricata and M. carlottensis. This reduction occurred over sediment having relatively high concentrations of amonium and PCB's.

206. Species that showed no seasonal trends in concentrations generally were larger in size showed poor recoveries. Those species that prefer habitats outside of Elliott Bay were most severly affected showing little or no recovery. These species are considered climax species since they will probably require more time for their reestablishment in Elliott Bay. Examples are the pelecypods Nemocardium centifilosum, Nuculana minuta, and Megacrenella columbiana, the gastropods Barleeia sp. and Mitrella gouldi, the sedentarian polychaete tube-dwellers Praxilella gracilis, P. affinis, Asychis similis, Pectinaria californiensis and Laonice cirrata and the errantian tube-dweller Onuphis iridescens. Decline of these tube dwellers was noted in addition to small numerous brittle tubes whose occupants were unidentified.

207. In general, organisms whose habitats occurred outside of Elliott Bay were the most severly damaged (Table 4). Those species preferring near river habitats or stressed habitats were least damaged; such trends were predicted by Sanders 1968 and Johnson 1974. Molluscs especially the gastropods, did not recover as rapidly ad the polychaetes; the errantian polychaetes recovered faster than most sedentarian polychaete occupants, especially large tube dwellers.

Comparison recolonizers with other studies

208. The opportunistic polychaetes found in this study were morphologically similar to those found in other studies. For example the selective opportunist, Ammotrypane aulogaster is analogous to the opportunistic Armandia brevis reported by Oliver et al. 1976, both

species being motile deposit-feeding polychaetes. In this study the tube dwelling species Polydora uncata was the dominant selective opportunistic species. P. ligni is one of the most consistently reported shallow opportunistic species (Saila et al. 1971, Pratt et al. 1973, Dauer and Simon 1976, Grassle and Grassle 1974). Nonselective opportunistic species found to increase in the fall were the polychaetes that normally dominate river-influenced nearshore habitats, such as E. longa, Aricidea longicornuta and Trichochaeta multisetosa. Individuals of Eteone sp. have been reported as having opportunistic characteristics by Slotta et al. 1974, Dauer and Simon 1970 and Saila et al. 1972. Capitella capitata a frequently reported opportunistic species (Table 1) did not recolonize the disposal site, despite its presence in the Duwamish River. These opportunistic species have been reported first occupying defaunated areas caused by oil spills (Grassle and Grassle 1976) red tides, (Dauer and Simon 1976), solid wastes (Pratt et al. 1973), pulp mill wastes, (Rosenbwrg 1972, Malkoff 1976, Harman 1977b) harbor activity, (Reisch-Knawling 1971, Reish 1961), sewer outfalls, (Stephenson et al. 1975) and disposal sites (Oliver et al. 1976). The absence of C. capitata over the disposal site in Elliott Bay despite its occurrence in the shallower portions of the Duwamish River suggests the possible influence of the greater depth of the study area.

209. Increases in annuals accompanied late spring and summer increases in selective opportunistic species. At corner stations the clams Axinopsida serricata, Macoma carlottensis, and M. moesta alaskana, in addition to the polychaetes Heteromastus filobranchus, Lumbrineris luti and Euclymene zonalis, increased despite relatively poor recovery over the center of the impact site. However, some of these species are known to be more stress sensitive. In pulp mill-influenced habitats A. serricata H. filobranchus and L. luti declined (Harman et al. 1977b). Leatham et al. 1973 indicated a reduction of H. filobranchus over the disposal site. However, Mauer et al. 1974 described this species as a possible opportunistic species. Its rapid recovery along with C. capitata was indicated by Oliver et

al. 1976 over a relatively deep disposal site near a submarine canyon. H. filobranchus and L. luti occur in wood-rich muds associated with river sedimentation (Harman et al. 1977b, Richardson et al. 1977). L. luti as well as A. serricata may attain high densities in organic-rich sediment yet they appear sensitive to the stress conditions existing in Puget Sound (Harman et al. 1977b). During the above-discussed recruitment phase of this study benefited annuals also began their gradual increase over the disposal site reaching maximum concentrations during the December sampling despite declining concentrations of most species at the reference sites. The benefited annuals of this third phase consisted mainly of predatory worms or motile deposit feeders. Nonselective opportunists also increased at this time. In other studies, motile predatory worms such as Nereis succinea increased immediately after defaunation perhaps indicating superior resurfacing abilities compared to deposit feeding worms (Kaplan et al. 1975, Dauer and Simon 1974).

210. Complete recovery of community structure did not occur during the period of this study. Climax and nonbenefited annuals did not recover over the direct impact stations despite their presence or increases at marginal stations. Opportunistic species and benefited annuals did not return to their predisposal low values despite reference site declines. Other dredged material studies did not indicate the nature of recolonization since recovery was more rapid. However, studies of deep-water benthic communities suggest that opportunistic species would be excluded with increased time as they are replaced by more specialized species (Grassle and Sanders 1972). Experiments and a review of macrofaunal studies by Woodin (1974, 1975, 1976) postulate that with increased time tube builders would limit the mobility of deposit feeders. Rhoads and Young 1971, and Sander, 1968 describe increasing numbers of biologically accomodating species with time. Thus, the major factors influencing the final phase would be the interactions (predation, and biological accomodation) between organisms. The decline in the motile opportunist and most predatory worms appears to be caused by the

selective feeding by fish and the decline of opportunistic tube-dwelling species may be reduced by the grazing of predatory worms. The rate of return of the expatraited climax species and those species more typical of the deep-water habitats may be dependent on the aforementioned declines in opportunistic and annual species. However, substrates with greater frequency of wood-plant debris and increased amounts of PCB, H_2S and NH_3 may be too great a recolonization barrier for the climax species and nonbenefited annuals thereby preventing their reoccupation of the direct impact site.

Rate of recovery

211. In this deep-water experimental disposal site a low recovery rate was documented compared to other studies which had a rapid recovery rates that were located in shallow and water-turbulent habitats. Recovery in most of these studies occurred in less than 1 year, while in this study recovery was not as complete after 9-months, despite sampling beyond the recruitment period. Slotta et al. 1974 indicated a 7-day recovery in a shallow tidal estuary channel. Disposal site recovery was also rapid in wave-impacted habitats such as those reported by Oliver et al. 1976 and Richardson et al. 1977. Scuba observations by Goodwin (1975) in a tidal channel also indicated a rapid recovery. Recolonization within one year was also reported in estuaries and harbors by Oliver et al. 1976, Mauer et al. 1974, Kaplan et al.1975, Saila et al. 1972 and Pfitzenmeyer 1960. Both fish and plankton studies indicate immediate recovery within days compared to the aforementioned longer rates of the macrofauna benthic studies (Cronin 1970).

212. This study, as well as others conducted in either deep, nonturbulent waters or embayments having poor or weak water circulation shows a longer and, in some cases, imcomplete recovery. A dredged channel in Tampa Bay, Florida is still imcomplete after 10 years of recovery Taylor and Saloman 1968. Off another disposal site (150 m depth) in Puget Sound, Fourmile Rock, showed a reduction in molluscs and polychaetes compared to adjacent seabottoms despite a 20-year period with no disposal activity, Harman et al. 1974 . In areas of San Francisco Bay away from rapid changes in salinity the restoration of the bottom

study (Anonymous 1970). A slow recovery rate was observed at the head of a submarine canyon off the California coast (Oliver et al. 1976).

Evidence of Succession

213. Oliver et al. 1976 recognized only two phases of recovery an opportunistic dominant phase and a normal occupant recovery phase. Grassle and Grassle 1974 describe a continuum between early opportunistic species arrivals and a more gradual return of normal occupants. This study recognized at least three phases: 1) a rapid recolonizer and normal occupant resurfacing and adjustment phase, 2) a selective opportunistic and annual species recruitment phase and 3) a benefited phase or density increases for those species preying on opportunistic species or occupying niches left by nonbenefited annuals and climax species. Additional phase(s) are most likely present that would witness the return of the nonbenefited annuals and climax species.

Immediate recovery phase (phase 1)

214. The first phase was an immediate recolonization characterized by the return to the disposal site by motile shrimp and demersal fish. Cronin 1960 and Saila et al. 1972 also indicate immediate (within days) recolonization by fish and shrimp. Oliver et al. 1976 documented rapid intrusion of megafauna by starfish and other large paracarid crustaceans. A rapid initial colonization by mobile paracarid crustaceans and/or opportunistic polychaetes were recognized by Saila et al. 1972, Kaplan et al. 1975, Oliver et al. 1977 and Richardson et al. 1977. In this study mobile paracarid crustaceans such as amphipods, tanadaceans, and cumaceans had low densities and did not recover rapidly, a trend also observed by Oliver et al. 1976 in his deep stations.

215. During this immediate recovery phase slight increases in early springtime were probably caused by migration or resurfacing of normal occupants that survive the initial disposal impact. In this study a 3-month period elapsed before a marked increase in the benthic macrofauna occurred during the summer recruitment period (phase 2). Only

slight increases in the macrofauna occurred at the margins of the disposal site suggesting an addition of specimens by migration or by physical transport of organisms into the disposal grid area. Most other studies indicated a more rapid improvement immediately after disposal suggesting that either the disposal activity occurred during seasonal recruitment or that rapid recolonization occurred due to migration of physical transport of organisms by currents into the disposal site (Richardson et al. 1976, Oliver et al. 1971).

216. Most studies indicate that deposit-feeding and tube-dwelling polychaetes suffer more than mobile organisms from direct burial (Richardson et al. 1976 and Keck et al. 1976). In this study the majority of the macrofauna consisted of small tube dwellers and deposit-feeding worms and clams that live primarily in the upper 2 cm and appeared to be weak burrowers incapable of resurfacing through the disposal material. Thus, the immediate reduction in the macrofauna over the entire grid disposal area could be expected since the entire area was covered by disposal material.

Opportunistic phase (phase 2)

217. The second phase was detected in late spring and during the summer months when opportunistic species increased primarily over the direct impact site of the disposal material. Over this site the polychaetes *Polydora uncata* and *Ammotrypane aulogaster* increased quite markedly compared to their rare occurrences prior to predisposal time. Other nonselective opportunistic species occupied most of the disposal grid areas especially on the eastern side, which is more influenced by the Duwamish River suspended load sedimentation. These opportunistic species were those normally found in the nearshore, river-influenced areas of Puget Sound such as *Amphicteis scaphobranchiata*, *Eteone longa* and *Aricidea longicornuta*. During this same phase marginally influenced areas showed a major increase in densities at corner and side stations in nonbenefited annuals or those species that did not increase over the direct impact site. This increase is probably a response of normal occupants to voids left by the impacted climax species.

Benefited annual phase (phase 3)

218. The third phase was characterized by the increase in predatory worms and the reduction of opportunistic species. Reduction in A. aulogaster was caused by selective feeding by flatfish while tube-dwelling opportunistic worm species were probably reduced by the increased predation caused by the increased presence of predatory worms. Unfortunately, the project ended before the disappearance of the opportunistic species occurred or the lessened influence of the benefited annuals or predatory worms could be discerned.

Climax phase

219. The final phase should document the return of nonbenefited annuals and climax species. The sampling period did not witness increased concentrations over the direct impact site of either these species. The nonbenefited annuals are expected to recover before the expatraited or climax species, mainly because of their greater reproductive rates as evidenced by their large seasonal changes in concentrations during the study. Most climax species were large worm species with straight tubes and probably had low reproductive and growth rates since they showed no significant seasonal changes in either biomass or density. Climax pelecypods were epibenthic or had a high degree of shell ornamentation with normal habitats outside Elliott Bay.

Factors Influencing Relative Impact and Succession of Macrofauna

Depth of burial of organsims

220. The most obvious factor influencing the nature of disposal impact on the benthic community is the depth of burial of the community by the disposed dredged materials. Bathymetric surveys suggest that over the direct impact site the disposal mound was 9 ft high and decreased to less than one ft towards the margins of the disposal grid stations. Complete smothering of the benthic fauna was evident by the near-defaunated surface located at stations 7, 10, and 11. At the margins of the sampling grid the larger clams Macoma moesta alaskana, Nuculana

minuta and M. carlottensis appeared to have a greater survival rate, as evidenced by the high number of samples these species occupied immediately after disposal compared to their predisposal and postdisposal relative frequencies. These clams have good digging shapes in contrast to those which did not resurface that were small or braod in cross-section profiles, such as A. serricata, Nemocardium centifilosum, Megacrenella columbiana, and Compsomyax subdiaphana.

221. The gastropods appeared to have very little ability to resurface through the disposal. The presence of mature adults and their late recovery (December) suggests gastropod recolonization primarily occurred via migration rather than by recruitment or resurfacing through disposal. Despite the thin surficial disposal at the sides and corner stations, a high proportion of the large worms did not resurface such as Praxilella affinis, Pectinaria californiensis, Laonice cirrata, Onuphis iridescens and Glycinde armigera. Smaller polychaetes, such as the tube-dweller Euclymene zonalis and the burrowing deposit feeder Heteromastus filobranchus, had relatively good immediate recoveries at these marginal stations suggesting their better resurfacing or burrowing abilities.

Turbidity and water column characteristics

222. Water column studies were able to detect a turbid cloud 25 m thick that quickly dissipated from the disposal site areas. Data also show declines in oxygen in the lower two thirds of the water column. No water column studies of the pelagic life were conducted. However, the rapid dispersal of the sediment cloud and a review of the literature (Cronin 1973, Westley et al. 1973, Saila et al. 1972, Flemer et al. 1968) suggests that no serious impact on the fauna or the flora should have taken place within the water column. The existence of a turbid cloud remaining close to the sea bottom was not indicated by the turbidity studies. However, most of the organisms found in the study areas should be adapted to a turbid bottom because of their close proximity to Duwamish River. Therefore, no damage to the benthic community from the turbid disposal cloud is expected. Richardson et al. 1976 also postulated that turbidity and resuspension of sediment had no signficant effect on the macrobenthic assemblages.

Sediment composition, texture and associated interstitial water

223. A major change in the sediment composition occurred from equal quantities of rock and wood in the washed residue to that of a wood-plant debris dominated substrate. Studies by Chang and Levings 1976 suggest a greater avoidance of wood substrates by most organisms. A high frequency of wood debris would present obstacles to burrowing activities or building of straight tubes by polychaetes. The poor recovery of the large tube-dwelling polychaetes appears to support this view. Fine wood debris would also have the tendency to physically obstruct deposit-feeding activities. The abrupt color change at the surface of grab samples would suggest that most occupants remain in the first few centimeters of the bottom sediment.

224. The blackened H_2S-rich sediment immediately below the surficial layer may also present a chemical barrier to the infauna. Interstitial water chemistry studies by the EPA and the University of Washington indicate increases in ammonium (NH_2) and PCB's over the same stations (7, 10 and 11) where the macrofauna had lowest concentrations and poorest recovery. The poor recruitment at these stations, despite the high rate of recruitment at the corner stations, would suggest the possible impact of the increased pollutants (PCB, NH_3, H_2S) over the impact area.

Promimity to adjacent habitats, depth of water and/or degree water turbulence

225. The rate at which disposal sites can be recolonized depends in part on the availability of larvae, juveniles, or adults. No sediment or larval settlement traps were used in this study to compare the dominant larval components of the water column with the natural sea bottom recolonizers. However, seasonal increases in the summer of both opportunistic species and normal occupants that had benefited and nonbenefited annuals characteristically suggest their greater larval availability in the water or within river habitats. For example, the selective opportunist Polydora uncata dominates the upriver portion of the Duwamish River. Many of the nonselective opportunists prefer river or nearshore habitats such as Eteone longa and Amphicteis scaphobranchiata. The selective opportunist

Ammotrypane aulogaster is more frequent in the shallower portions of Elliott Bay, a species that also occupies the river and pulp mill pollutant-stressed estuaries near Everett. Many of the benefited annuals or predatory worms are more concentrated in the shallow habitats of Elliott Bay; thus, the majority of the recolonizers had abundant sources within the river or nearshore habitats. The poorest response was exhibited by species more typical of the deep habitats or those organisms that occur more typically outside Elliott Bay or found more distant from river-influenced habitats. Richardson et al. 1977 and Saila et al. 1972, also indicated that deeper offshore inhabitats did not readily recolonize the disposal site.

226. The absence of strong currents and the deep depths of the study area compared to other dredged material studies were major factors responsible for the lack of physical transport of specimens into the disposal site. A 3-month period occurred during which no significant changes in density, biomass, and species richness occurred until late spring or early summer. Thus, recruitment was the major method of recolonization of the disposal site.

227. Oliver et al. 1976 also indicated seasonal recruitment of juveniles as a major recolonization mechanism in deep, nonturbulent habitats. In contrast, shallow dredged material studies that had strong currents or more turbulent waters that physically transported species into the disposal site had rapid recovery (Oliver et al. 1976, Richardson et al. 1976). In addition, many of the organisms in these turbulent habitats were rapid swimmers or were very mobile, making migration a more important recolonization mechanism than what seems to be the case for this study.

Time, productivity, and predation

228. Time of year was important in influence the nature of recolonization of the disposal site. Recruitment of both annuals and opportunistic species occurred during the summer months. Stomach analysis of fish also suggested that increased predation by flatfish appeared to be very selective in their feeding, avoiding many dominant benthic

polychaete tube dwellers. Macoma carlottensis, which occurs in lesser frequencies on the sea bottom beds, was preferred to the more abundant small size pelecypod Axinopsida serricata. Selective predation by the Dover sole of Ammotrypane aulogaster was probably a significant factor in the reduction of these opportunistic species.

Summary

229. In this study seasonal recruitment of juveniles was the major mechanism in the recolonization of the direct impact area; recruitment and resurfacing were the major recolonization mechanisms for marginal stations. The presence of numerous small tube builders and small clams that make up the community discourage resurfacing through borrowing over the central stations. The great depths, weak currents, and lack of tidally or wave-induced water turbulence were major factors preventing physical transport of specimens into the disposal area. However, recolonization of the disposal site eastern margin suggested the influence of the Duwamish River suspended load sedimentation. Except for shrimp and fish, there are little data to support the theory of immediate migration of macrofaunal organisms into the area. The elevated concentration of PCB's and NH_3 over the direct impact site and the associated poor recovery of A. serricatus suggest possible chemical influence on the recolonization. The relative increase in wood and plant debris also may play an important role in limiting many of the large tube-building polychaetes. Predation by flatfish is importnat in reducing concentrations of motile opportunists (A. aulogaster), predatory worms, and the clams M. carlottensis and A. serricata. The rarity of tube-building organisms in flatfish suggests the reduction of opportunistic tube-dwelling species by predatory worms. The relative role of the tube builders on motile surface feeding deposit-feeders is unknown but may also influence the last phase of recolonization.

PART VI: CONCLUSIONS, APPLICATION OF RESULTS AND RECOMMENDATIONS

Conclusions

230. The following conclusions are made from this study:

a. The entire experimental disposal grid was covered by the dredged material.

b. The east and west reference sites were not influenced by the disposal activity.

c. The maximum declines in densities, numbers of species, and biomass occurred over the central stations (7,10,11 and 6); least affected were the corner stations (1,4,13 and 16); side stations moderately impacted were stations 2, 9, 12 and 14 and to a lesser extent stations 3, 5, 8, and 15.

d. The greatest rate of recovery did not occur until June, three months after disposal. This indicates that recolonization occurred principally through recruitment of larvae and juveniles during the summer months.

e. Fish and shrimp were first to occupy the disposal site. Three phases in the macrofauna recolonization occurred over the disposal site. The initial phase of recolonization occurred with organisms resurfacing through dredged material with seemingly minor contribution via migration or physical transport by currents. The second phase was characterized by summer increases in opportunistic polychaetes over the impact site and increases in annuals at the marginal stations. During the last phase of recovery predatory worms, benefited annuals, and nonselective opportunistic species increased over the disposal site disproportionately compared to the reference sites. Climax species and most nonbenefited annuals did not recover during the 9 months over the directly impacted stations (7,10 and 11). There was no significant contribuiton of species transported from the river dredge site to the disposal site.

f. Expatriated climax species or those species whose normal habitat occurs primarily outside Elliott Bay, showed no signs of recovery.

g. Most species that showed no significant seasonal changes in densities or biomass at the reference sites did not recover over the disposal site.

h. Most of the opportunistic species were those found in river-influenced habitats or stress habitats of Puget Sound.

i. Polychaete worms had a greater rate of recovery than pelecypods, crustaceans and gastropods; the latter appeared to have the slowest rate or recovery.

j. Burial and resulting suffocation was probably the principal cause for decline in most macrofaunal components.

k. The change from equal amounts of wood and rock substrate to those of greater than 95 percent wood substrates as well as associated high concentrations of PCB, H_2S and NH_3 seemed to have had a major detrimental effect on the recovery of many of the organisms.

l. Deep disposal sites recovered at slower rates compared to shallow disposal sites.

m. During the winter most flatfish did not feed and had a higher proportion of amphipods and other small crustaceans in their stomach contents. Throughout the spring and summer months most flatfish preferred the pelecypods, Macoma carlottensis and Axinopsida serricata, followed by polychaetes and small crustaceans.

n. The dover sole selectively fed on motile opportunistic deposit-feeding polychaetes such as Ammotrypane aulogaster and seemed to avoid many of the abundant tube-dwelling polychaetes.

o. Stomach contents of fish at the western disposal sites were significantly different from those at the disposal and eastern reference sites; a regional difference similar to macrofaunal distribution.

Application of Results

231. Experimental disposal studies can be used to assess baseline ecological data as well as to develop criteria for disposal site selection and prediciton of dredged material impact on the benthic community.

Assessing baseline ecological data

232. The results of this study suggest varying sensitivities and recovery rates for opportunistic species, annuals and climax species. The presence of opportunistic species and benefited annuals in the absence of nonbenefited annuals and climax species may suggest stress conditions in the habitat. However, such communities may "recover" to pre-disposal conditions quickly.

Conversely the dominance of climax and nonbenefited species may indicate well-established "mature" climax communities which recover slowly. In the shoreline studies of estuaries near Everett where seabottoms are influenced by pulp mill activity and river sedimentation the macrofaunal communities are dominated by the same opportunistic species reported by other studies (Table 1), (*Ammotrypane aulogaster*, *Armandia brevis* and *Capitella capitata*). In this same area the estuary, Port Susan had greater than 50 percent oyster larvae abnormalities associated with waters having a high sulfite liquor content (Cardwell and Woelke, 1976) and sea bottoms with reduced numbers of annuals and climax species (Harman, et al. 1976b). This area of low concentration of benthic organisms contained occasional benefited annuals or predatory worms typical of the shoreline study such as *Glycera capitata* and *Glycinde armigera*. No climax species found in this study were present at Port Susan despite the presence of numberous empty tubes belonging to such climax species as *Praxilella gracilis*, *P. affinis*, and *Asychis similis*. Another example of opportunistic species occupying an extreme stress habitat is Everett Harbor, an area directly impacted by pulp mill sludge debris. Here, *Capitella capitata* dominates the benthic macrofauna while many of the typical adjacent basin-dwelling clams and worms are absent. In this same region many of the non-benefited annuals in this study are found in organic enrichment sites or river deltas, more distant from pulp mill enffluents. On the Stillaguamish River forset beds calcareous foraminifera, *Lumbrineris luti*, *Heteromastus filobranchus* and *Euclymene zonalis* are abundant in contrast to their reduction or absence on the forset beds of the Snohomish River which is adjacent to a sulfite liquor discharge portal (Figure 38). The low concentration of *Axinopsida serricata* and the greater proportion of *Macoma carlottensis* in the stressed area of Everett estuaries correlated well with the poor response of *A. serricata* in the disposal study. Many of the species that did not recover over the disposal site were also those species that declined or were absent near the more stressed areas of the Everett estuaries (e.g. the pelecypods, *Nemocardium centifilosum* *Nuculana minuta*, *Megacrenella columbiana* and worm tubes SR-1,-10,-7).

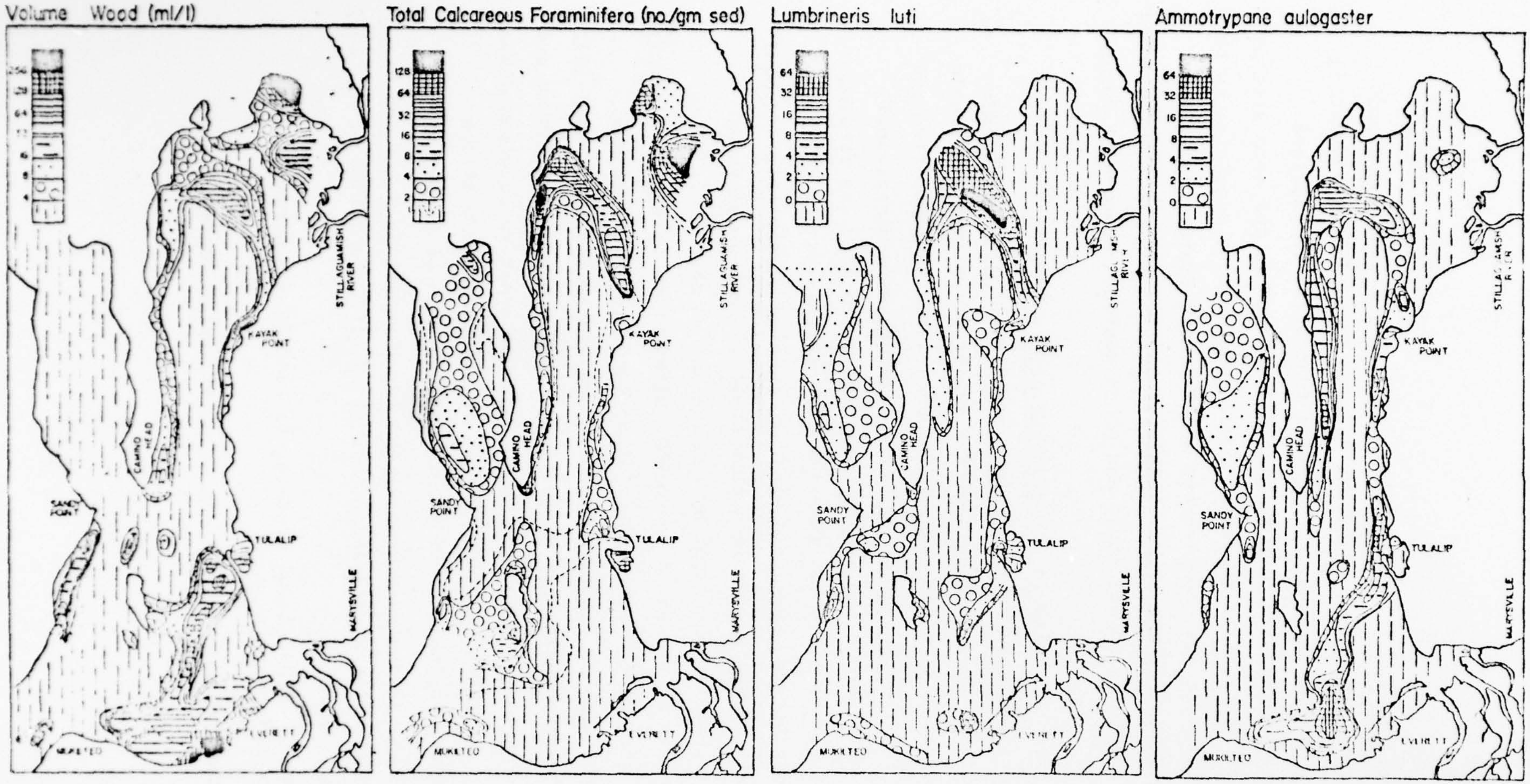


Figure 38. Retention sites of wood debris in estuaries adjacent to Everett are areas usually high (except in polluted areas) in both meiofaunal and macrofaunal densities and number of species. Calcium carbonate secreting foraminifera and the polychaete L. luti are nearly absent on sea bottoms seemingly influenced by pulp mill waste disposal. The response of both the meiofaunal and macrofaunal species to varying degree of stress in estuaries adjacent to pulp mills of Everett correlates well with response of the same species over the experimental disposal site of this study. A. aulogaster, a motile selective opportunistic species of this study is frequent in the stressed estuarine areas. The more stress sensitive species or nonbenefited annuals of this sutdy, L. luti, is nearly absent on the delta foreslopes near Everett yet abundant on delta foreslopes more distant from pulp mill sulfite waste portals (Harman et al. 1977b).

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Other opportunistic species in the Shoreline study Eteone longa and Amphicteis scaphobranchiata, are found abundantly on deltas suggesting their stress tolerance. Thus, the species that first recolonized the experimental disposal site were also those found in the more stressed areas of the estuaries near Everett. Those species more sensitive to the dredged material were also most stress sensitive in Everett estuaries. (Table 4) lists many of the stress sensitive species for Puget Sound based on this experimental disposal study and other regional studies of Puget Sound.

Use in development of criteria for disposal site selection

233. Suggestions and recommendations based on literature review. Based on the literature, shallow habitats appear to be more preferable for dredged material disposal compared to deep water habitats from the standpoint of their more rapid recovery. However, more macrofaunal resources are abundant in the shallow habitats which serve as feeding grounds and as refuge sites for juvenile fish (Miller et al. 1975). In contrast, deep habitats, protected habitats recover slowly from disposal. However, overall damage may be less than those in shallow habitats since resource items sought after by man are not as abundant. Waste disposal at sea is at present a reasonable alternative to the more costly suggestion of utilizing dredged material on land or developing new dredged material uses as proposed by Booth and Saucier 1974 and Reed 1972. Because of the vast present day demand for disposal areas, Andrelunas and Hard 1972 suggest that at present, there is no alternative to ocean disposal.

234. Most researchers suggest that it is necessary to initiate guidelines for use in the selection and consideration of both dredging and disposal site evaluation. Many of the recommendations discussed by Saila et al. 1972, Slotta 1973 and Oliver et al. 1972, and IMCO et al. 1972 are summarized below.

a. Avoid disposal and dredging in feeding and nursery or recruitment areas.

b. Avoid disposal and dredging in migration routes.

c. Avoid disposal during periods of migration or recruitment of adults and juveniles, especially commercial species.

d. Avoid dumping dredged material that is highly polluted with toxic substances or pathogens.

e. Consider the community resilience of both retention and dispersal areas when selecting disposal sites.

f. Dispose of dredged material in areas having similar substrate characteristics.

g. Assess and monitor the differences between before, during, and after disposal characteristics in terms of influence of currents, turbidity, sediment composition and texture, and water and sediment chemistry relative to the associated impacts on the community.

235. Application of Results to Disposal Site Selection in Puget Sound. When and where dredged material should be disposed are the principal questions that must be considered prior to dredging and disposal activity. The time of the year when this material is disposed must be considerate of the life cycles and histories of organsims within the community. This study indicates that disposal before the macrofaunal recruitment period during the late spring, summer and fall is preferable. Disposal in the late winter or early spring coincides with minimal increases in community densities and provides spring months for the impacted organsism to adjust to the dredged material. An adjustment period should be allowed immediately after disposal in order that occupant organisms can resurface through the dredged material and to provide time for migration or physical transport of organisms into the habitat before opportunistic species can recolonize the site. As indicated in this study the maximum recolonization period occurred immediately after larval settlement. Stomach analysis also suggests less grazing by fish during the wintertime and early spring months thereby providing less grazing pressure on surviving and recolonizing organisms.

236. Where disposal should take place in Puget Sound must consider the characteristics of the dispersal and retention sites of sediment and the associated community resilience to disposal impact and the communities

response to various types of substrates. Elliott Bay typifies a sediment retention site where the disposed sediment would not easily be dispersed by nearbottom currents. The high degree of spatial heterogeneity of Elliott Bay provides a large number of sources of opportunistic and expatriated species such as from river habitats, nearshore shallow habitats, and the Duwamish Head area where displacement of shallow organisms and sediment into the deeper areas is an important process. In the deeper areas of Puget Sound poorer recovery should occur since the areas are distant from sediment sources or habitats that recruit abundant opportunistic and annual species. Dumping of wood-rich sediment should be avoided in the low wood content deep water muds of Puget Sound. Disposal on retention sites, river forset beds or deltas resulting from tidal channel sedimentation would seriously impact these areas since they provide abundant food items for fish and shell fish. In retention sites most organisms are deposit feeders or good burrowers and for the most part can adapt to disposed muds. However, these organisms may be highly impacted by cobbles, gravels, or coarse wood debris that is dumped in their more typical muddy substrate. At intermediate depths in Puget Sound, no net motion occurs between tidally and river-induced outflowing estuarian water and incoming oceanic water. At this zone wood debris and increasing amounts of mud are found as well as displaced organisms from shallow habitats. This no net motion zone has relatively high densities of species richness of both macrofaunal and demersal fish compared to the shallow and deep habitats. Outside Elliott Bay these zones are associated with gravels and sands with minor amounts of mud. Many of the organisms associated with this habitat are suspension feeders or epibenthic organisms such as pectins, sponges, tunicates, and chaetopterian worm tubes. Many of these species occur in Elliott Bay such as Nuculana minuta, Nemocardium centifilosum, and Megacrenella columbiana and these did not recover after disposal. Therefore, disposal in this zone should preferably be avoided.

237. Shallow wave impacted and tidally impacted areas represent most sediment dispersal sites. Disposal in Dana Passage, a tidal channel, indicated a rapid dispersal of sediment and subsequent rapid

recovery (Westly et al. 1975). Disposal in shallow wave-impacted habitats probably would also recover rapidly. The oceanic habitats off the coast of Washington and California indicated that wave action enhanced the rapid recolonization of dredged material disposal areas (Richardson et al. 1977, Oliver et al. 1976). In dispersal areas, the nature of the dredged material substrate should be considered. Blue clays in the littoral dispersal habitats of Shilshole Bay and Elliott Bay have unusually low concentrations or organisms. Therefore, blue clay should not be dumped in marine habitats. Muds with high wood contents like the blue clays would probably have a greater impact on the rate of recolonization (based on poor responses of organisms in laboratory tests and on field evidence). In most of the dispersal habitats sands and coarse gravels may actually enhance the community structure by increasing species richness, density and biomass. A major objection to nearshore and shallow-water sediment disposal is the presence of greater numbers of resource clams and other commercial organisms.

238. Recommended disposal site of Duwamish River dredged material. At present the disposal of Duwamish River dredged material occurs off Fourmile Rock, a deep-water disposal site. Although the site has not been studied biologically in sufficient detail, the few samples Shoreline has collected and studied indicate slower recovery rates than that of the Elliott Bay experimental site. The Shoreline earlier report (Harman and Serwold 1974) recommended disposal at Fourmile Rock based on its more distant location from resource areas such as the abundant shrimp of Elliott Bay and the migratory pathway of salmon and other fish. Based on this study it is believed that disposal of Duwamish River sediment is possible in Elliott Bay without major loss of resources to man or marine life. This recommendation is based on the following factors:

a. Relative high rate of recovery of normal habitat occupants that comprise food items for fish.

b. Opportunistic species being used as food items by fish.

c. The close proximity of the site to rivers and adjacent shallow habitats which provide sufficient resource areas for relcolonizing organisms.

d. The immediate recovery of fish and shrimp over the disposal site.

e. The greater adaptation of species in Elliott Bay to stress compared to those off Fourmile Rock.

239. A disposal site in the east submarine canyon of Elliott Bay may provide sufficient volume to contain the dredged material with a nominal areal exposure. Additionally, suspended sediment from the Duwamish River is currently deposited over this eastern site. Partial filling of the canyon would also eventually make bottom substrate available at intermediaite depths where communities are more species rich, more dense, and have higher biomass. The Elliott Bay disposal site would be improved if dredging occurred last in the more seaward portion of the Duwamish River Channel, with this material being used to cover up the more wood-rich, coarser grained first dredged materials from upriver.

240. Recommended future studies. Several questions have been raised by this study that merits future investigation. Since this study was conducted only during a 9-month period, seasonal trends between years were not well established and many questions remain. These questions include:

a. Why did the pelecypods decline and the polychaetes increase at both the reference sites and at the margins of the disposal sites?

b. Does the maximum concentration of species occur in the late summer and early fall and the corresponding low occur in the early summer and early spring?

c. What is the role of bed-load transport of fibrous plant and wood debris having shallow nearshore origins on the dispersal larvae?

241. The scarcity of sediment trap larval studies make definitions of annuals and climax species, via water column abundance, difficult. The lack of sampling stations beyond the disposal station grid was most unfortunate since it would have defined the total area of disposal impact. Many of the Shoreline earlier studies on the regional distribution of organisms in Elliott Bay and vicinity, and those in the Duwamish River, were based on small grab samples sizes (0.05 m^2). A future study using

a larger sampler and emphasing up-river and nearshore habitats of Elliott Bay in addition to other stress areas in the region should be conducted. More detailed studies should be conducted at Fourmile Rock, the Metro sewer outfall area, and former dredged material disposal sites in Shilshole Bay in order to determine the sources of opportunistic species and habitat preference by annuals and climax species. Future studies should also include epibenthic dredges in order to analyze the megafauna of the habitats. A follow-up of this study should continue long enough to document the return or failure to return of the non-benefited annuals and climax species and subsequent reduction of opportunistic and benefited annuals.

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APPENDIX A: RESULTS OF PILOT STUDY - PHASE I

RESULTS OF PILOT STUDY - PHASE I

1. The results of the pilot study are included since the choice of the experimental disposal site and reference station locations were based in part on these results. Speciation was not applied to polychaetes and most crustaceans because of time and cost limitations placed on collection, sorting, identification, and data presentation carried out during a 2-month period in November and December 1975.

Field Descripiton of Samples

Volume Bottom Sediment Samples Collected

2. Samples greater than 10 l were primarily collected in the eastern portion of Elliott Bay where mud with lesser wood and rock debris occurred (Figure A2). Shallow samples were usually less than 6 l, caused by problems in adequate penetration (less than 9 cm) of the grab sampler in mud and sands having high wood and rock debris content. The small samples did not appear to influence the concentration of the macrofauna plots. This would indicate that most benthic macrofauna species lived near the surface of the sediment where the smaller grab samples could penetrate.

Color, odor and presence of man influenced debris

3. Throughout most of the area olive-green sediment occurs with motling and blackened sediment increasing with penetration depth in the sediment (Figure A3). A surface brown layer of sediment occured near the mouth of the Duwamish River primarily on the eastern margin of the bay. This superficial layer most likely represents recent deposition of the rivers suspended sediment load. In the eastern portion of Elliott Bay samples show a thick (greater than 5 cm) yellowish olive-green surface sediment layer over a more dark olive-green to blackened sediment. The presence of this surface layer may indicate the active turnover and resuspension of near-surface sediment by deposit feeders. Surface layers are thin or absent in the western portion of the bay. Their absence may be explained by either;

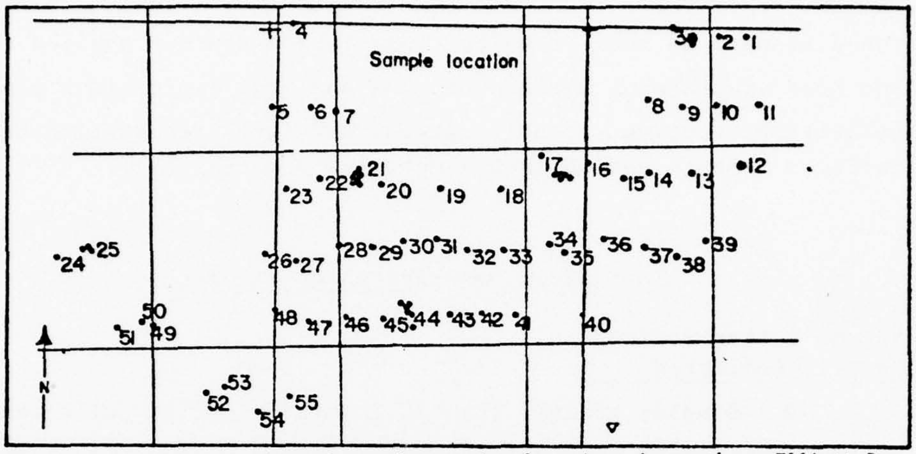

Figure A 1. Pilot study grab sample station locations in southern Elliott Bay.

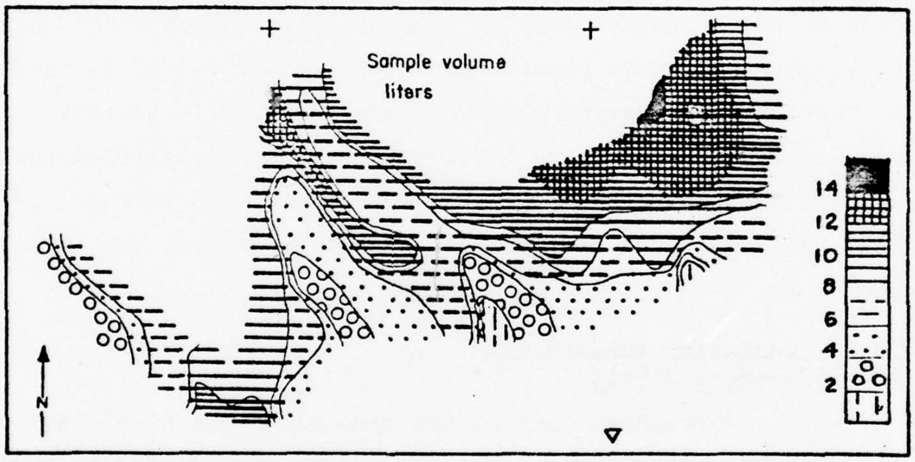

Figure A 2. Grab sample volumes. Note large samples in east Elliott Bay.

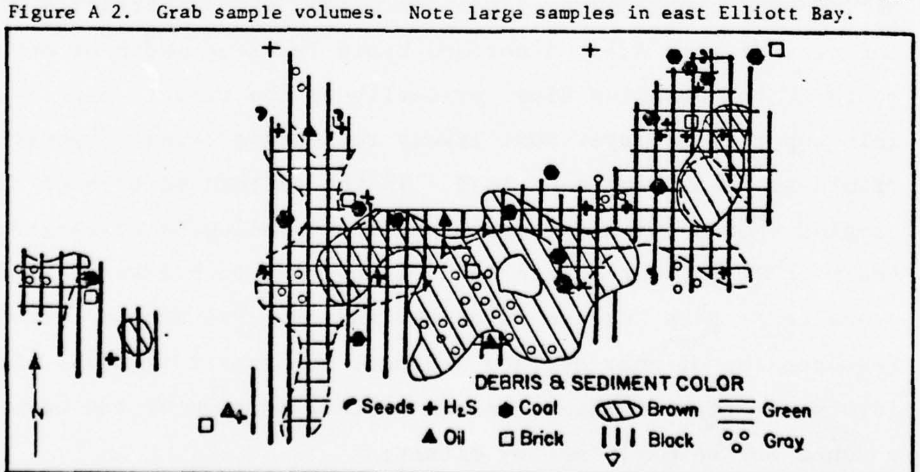

Figure A 3. Types of debris, odor and color of sediment.

a. An area of nondeposition of the river's suspended sediment.

b. High degree of mixing or homogenization of the surface sediment by organisms or

c. Removal of the surface layer by water flushing during sampling retrieval.

4. Most of the samples had small traces of an H_2S odor but never exhibited extremely strong odors typical of the shallow wood-rich muds adjacent to piers.

5. Coal was the most frequent contaminant observed. It was most abundant in the northeast portion of the study area adjacent to the ferry dock. Bricks, plastic and metal debris was scattered randomly throughout the area. Some samples contained abundant oil and tar in the sediment sufficient to coat picking trays and storage bottles. Large fruit seeds occurred sporadically in the area suggesting overboard disposal from the moored vessels.

Sediment Characteristics

Percent Sand

6. Low percentages of sand in the bottom sediment occurred in the eastern portion of the bay corresponding to areas having high frequencies of mud (Figure A4). The highest frequency of sand in the study area occurred primarily off the river mouth on the deep-water offshore delta. The high percentages and the high degree of variability found there are caused by varying amounts of rock and wood debris of sand size from former disposal activities or bedload transport of coarse wood. This regional study demonstrated a high percentage of mud on the eastern portion of the bay and, more typically, coarser sands on the western portion.

Composition of washed sediment residue

7. The washed sediment remaining in the 1 mm screen (sediment residue) consisted principally of rock (Figure A5), wood, and fibrous plant debris (Fibure A6). A higher degree of variability occurred between

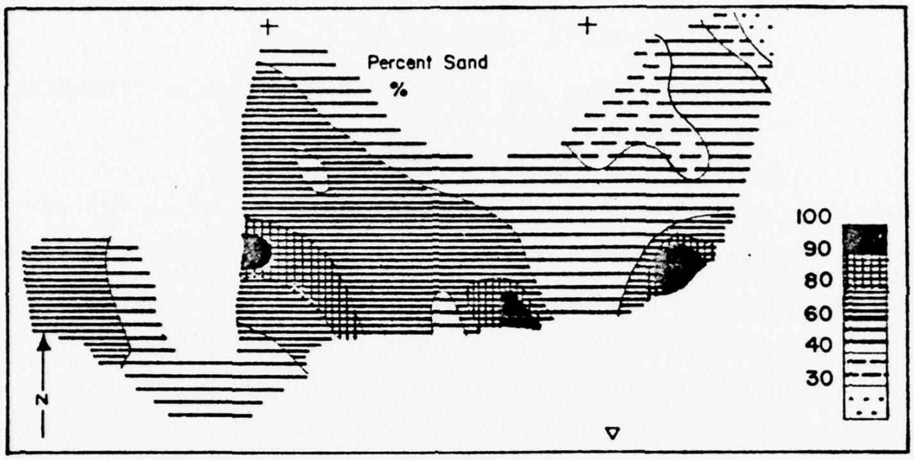

Figure A 4. Percent sand in bottom sediment.

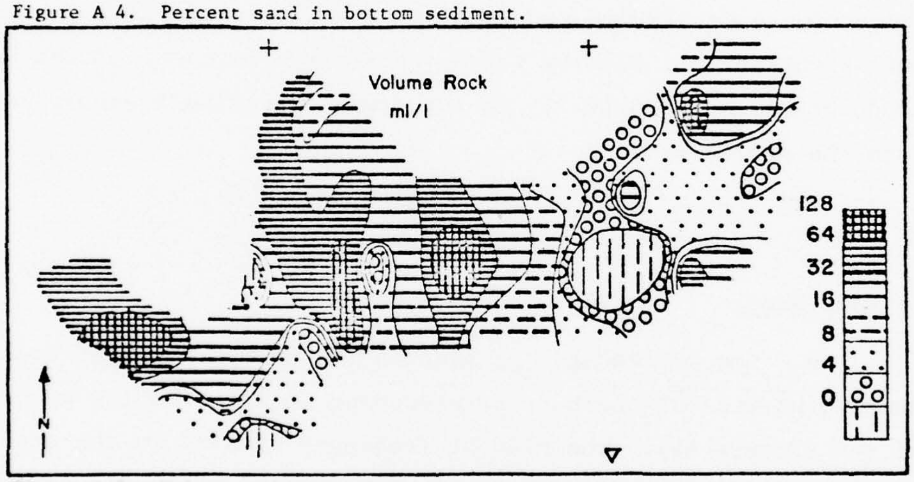

Figure A 5. Volume rock in washed sediment residue per grab sample.

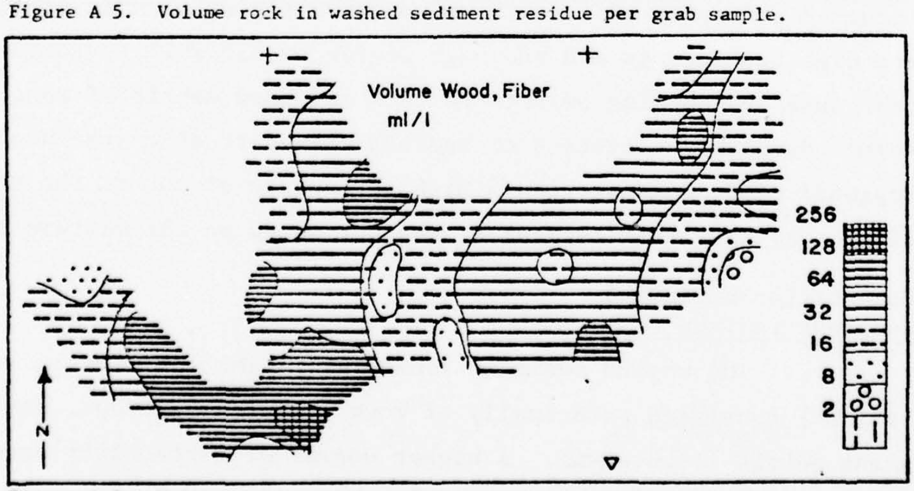

Figure A 6. Volume wood and plant fiber in washed sediment residue per grab sample.

stations for rock residue volume per sample than for plant and wood residue volume per sample. Rock volumes were generally higher over the disposal site and western portion of the bay. The high frequency of angular-shaped rocks and their large size suggest former disposal material or ballast from vessels. Rock volumes in the eastern portion of the bay consisted of large chunks of coal and brick. Plant and wood debris volumes were most abundant directly off the river mouth and primarily in the western portion of the bay, suggesting the direction of bedload transport. Greenish fibrous palnt debris occurred offshore suggesting probably preferential settlement zones. Directly off the mouth of the river abundant brownish fibrous peat-like debris occurred, again an indication of bed-load materials.

Molluscan Distribution

Gastropods

8. No apparent trends occurred either in the number of gastropod species or their densities (Figure A7). This trend is surprizing in view of the earlier study and other studies that suggest their decreased numbers in areas of high river influenced or sedimentation (eastern Elliott Bay). Mitrella gouldi (Figure A8) and Barleeia sp. (Figure A9) were the two most frequent species, although concentrations were low in contrast to their abundance in Liberty Bay and Dyes Inlet. Mitrella gouldi showed no east-west baysite preference. Off the river mouth and into the eastern portion of the bay, Barleeia appeared to show some preference. Other species found sporadically in the bay were; Natica clausi, Bittium subplanatum, Polinices lewesii, and Turbonilla sp. Outside Elliott Bay in the deeper basin regions and Shilshole Bay Bittium subplanatum is the most dominant gastropod. Its scarcity in Elliott Bay most likely suggests the regional effects of the Duwamish River sedimentation. Also rarely sampled but frequent outside the bay in the shallow habitats was Nassarius mendicus.

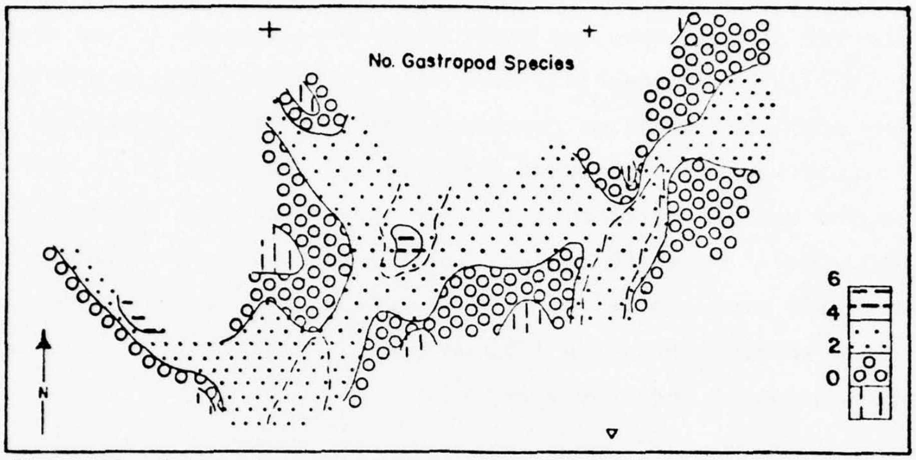

Figure A 7. Number of gastropod species per sample.

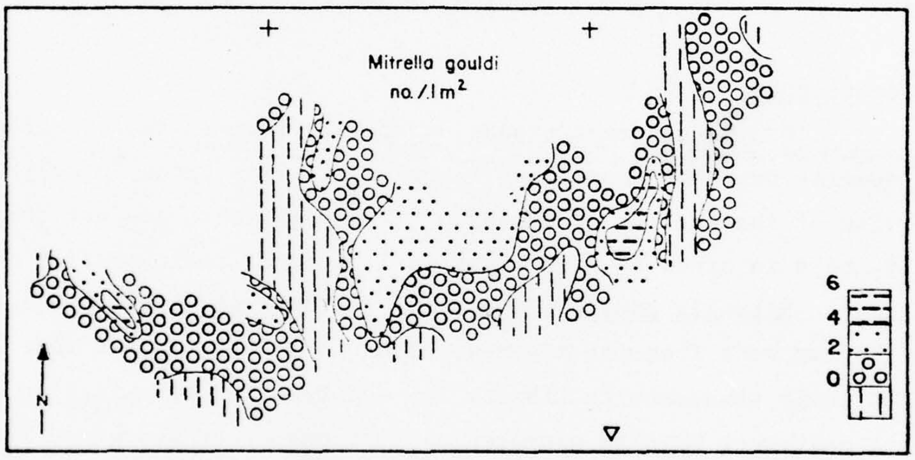

Figure A 8. Concentration of M. gouldi (numbers per 0.1 m^2)

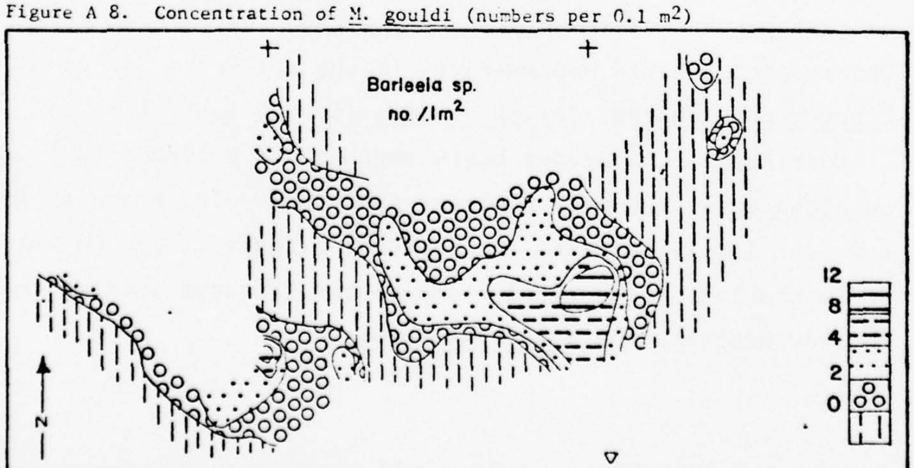

Figure A 9. Concentration of Barleeia sp. (numbers per 0.1 m^2).

Pelecypods

9. No significant regional trends occurred in the numbers of species present (Figure A10), although our earlier studies suggested a greater species richness in the western portion of the bay, especially in the shallower habitats. The dominant pelecypod was Axinopsida serricata (Figure A11), followed by lesser occurences of Macoma carlottensis (Figure A12), and Nucula tenuis (Figure A13). Both Nuculana minuta (Figure A14) and Nemocardium centifilosum (Figure A15) showed preferences for the western portion of the bay where their concentration was low compared to their more abundant occurrence outside Elliott Bay at intermediate depths having sandy or gravelly substrates. The highest concentrations of Axinopsida serricata occurred in the eastern portion of the bay near the mouth of the river's most shallow stations. This species is unusually rich in Elliott Bay compared to other areas of central Puget Sound, suggesting the possible influence of the river sedimentation and entrapment of the high amounts of organic debris. M. carlottensis and Nucula tenuis did not show any bay preference. Other pelecypods present, but lacking areal distribution trends, were Compsomyax subdiaphana, Lyonsia californica, Macoma moesta alaskana, Saxiclava artica, Lucinoma annulata, Pandora filosa, and Parvalucina tenuisculptis.

Polychaete Worm Distribution

Errantean Polychaetes

10. The highest concentrations of errantean polychaetes occurred in the eastern portion of the bay (Figure A16). Lumbrinerid and glycerid polychaetes were the two most abundant errantians found (Figures A17 and A18). Lumbrinerids showed some preference towards eastern portions of the bay while glycerids had a more ubiquitous distribution pattern. The two dominant species within these two worm families were Lumbrineris luti and Glycera capitata. Onuphids and goniadids (Figures A19 and A20) were represented primarily by Onuphis iridescens, Glycinde armigera,

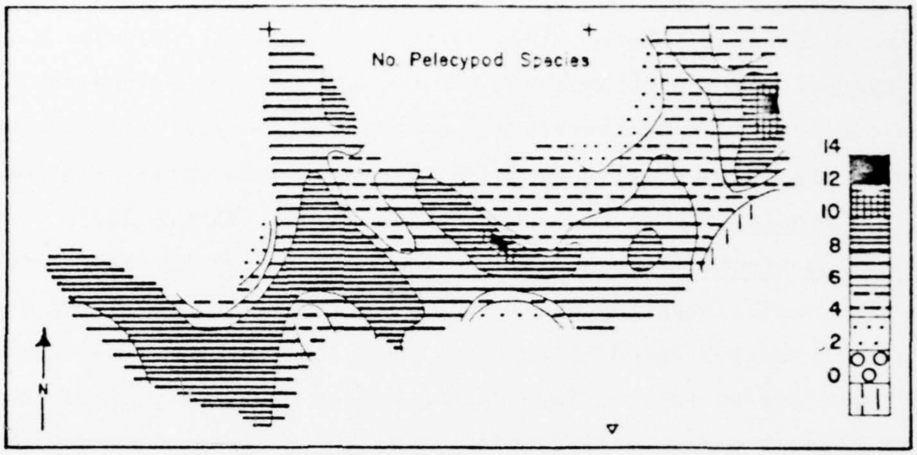

Figure A 10. Number of pelecypod species per sample.

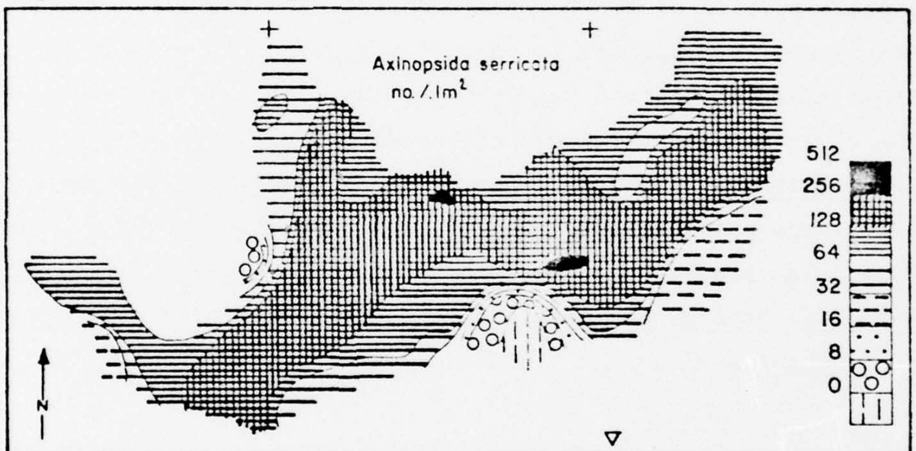

Figure A 11. Concentration of A. serricata (numbers per 0.1 m^2).

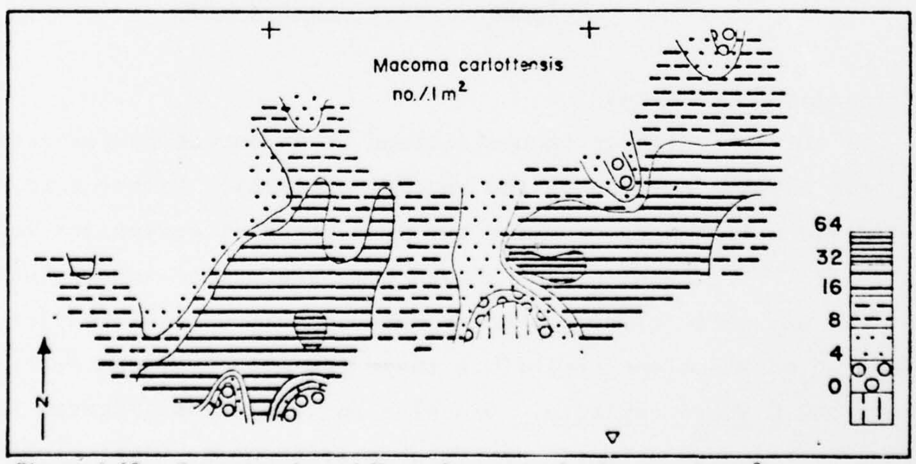

Figure A 12. Concentration of M. carlottensis (number per 0.1 m^2).

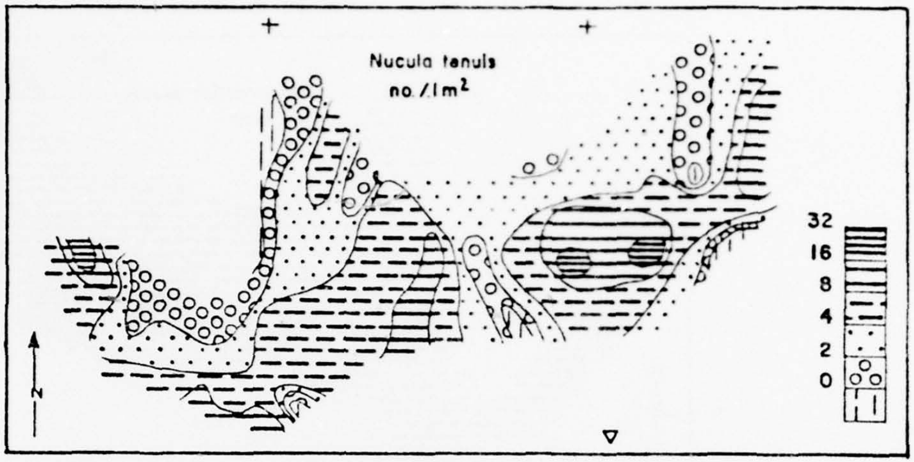

Figure A 13. Concentration of N. tenuis (numbers per 0.1 m^2)

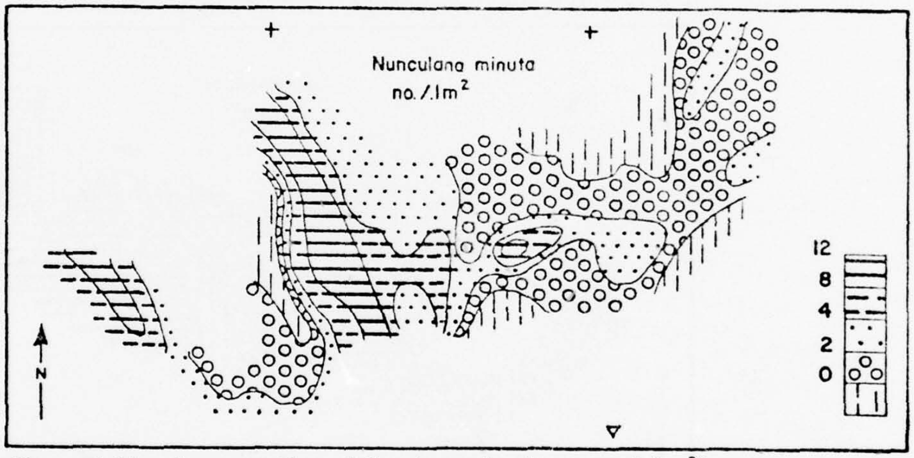

Figure A 14. Concentration of N. minuta (numbers per 0.1 m^2).

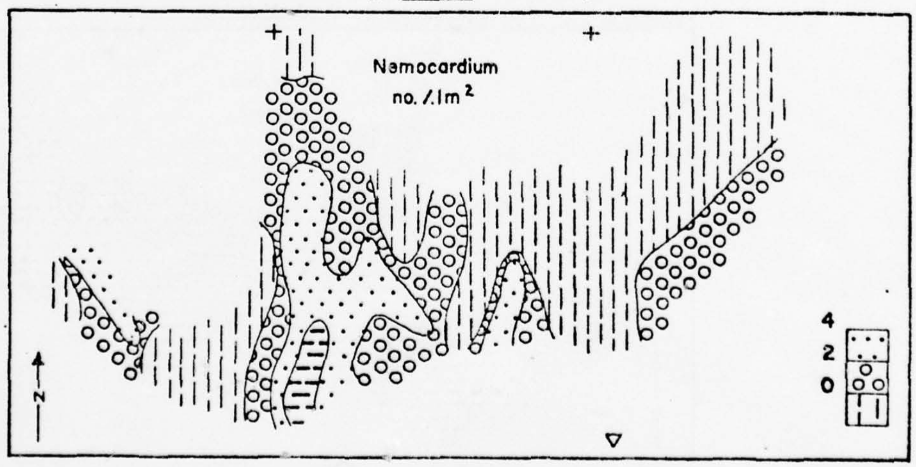

Figure A 15. Concentration of N. centifilosum (numbers per 0.1 m^2)

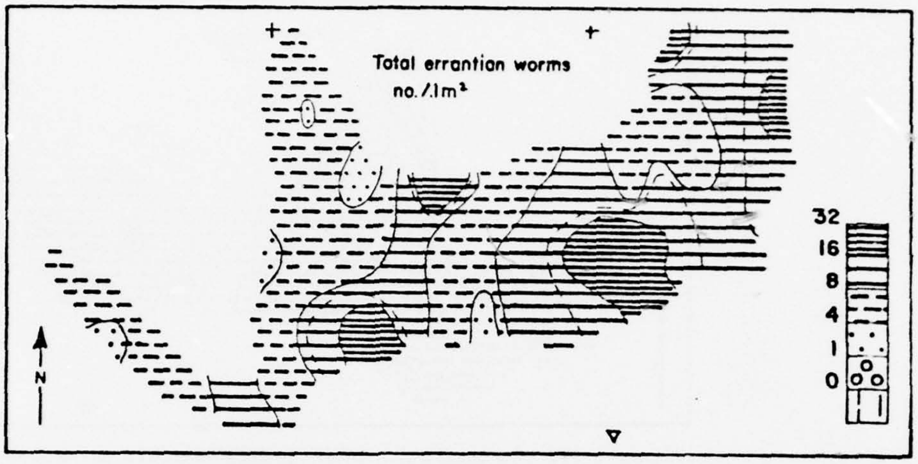

Figure A 16. Concentration of total errantean worms.

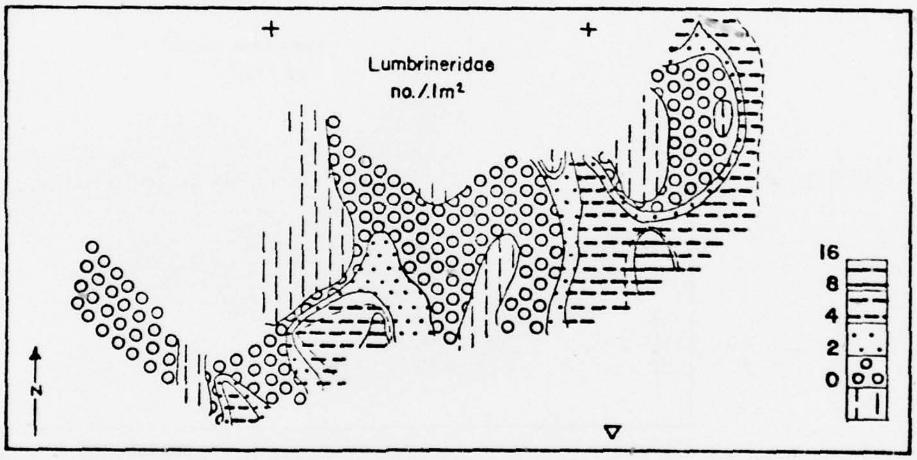

Figure A 17. Concentration of lumbrinereids.

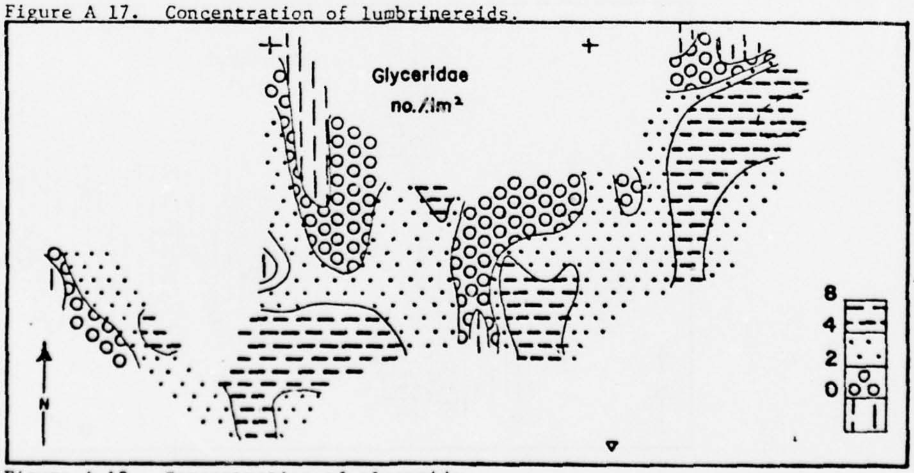

Figure A 18. Concentration of glycerids.

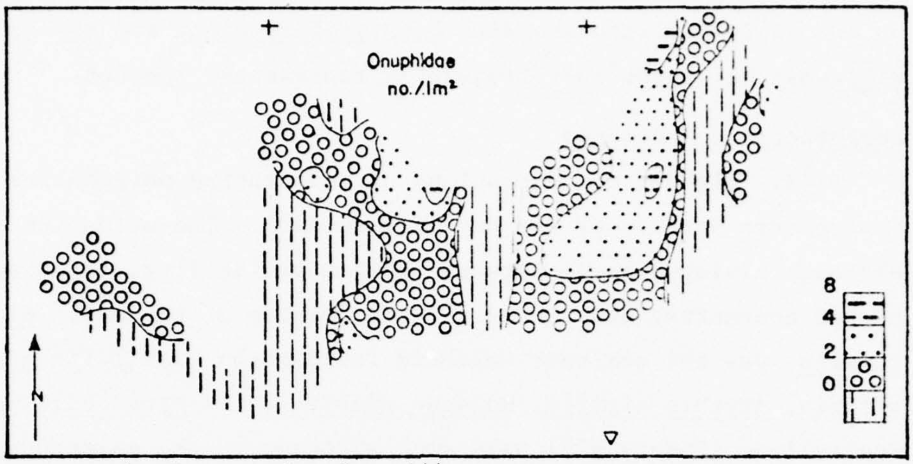

Figure A 19. Concentration of onuphids.

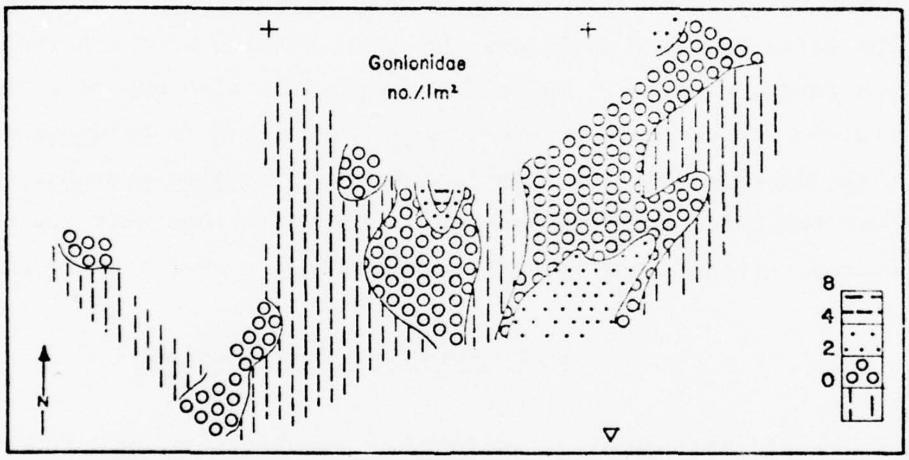

Figure A 20. Concentration of gonionids.

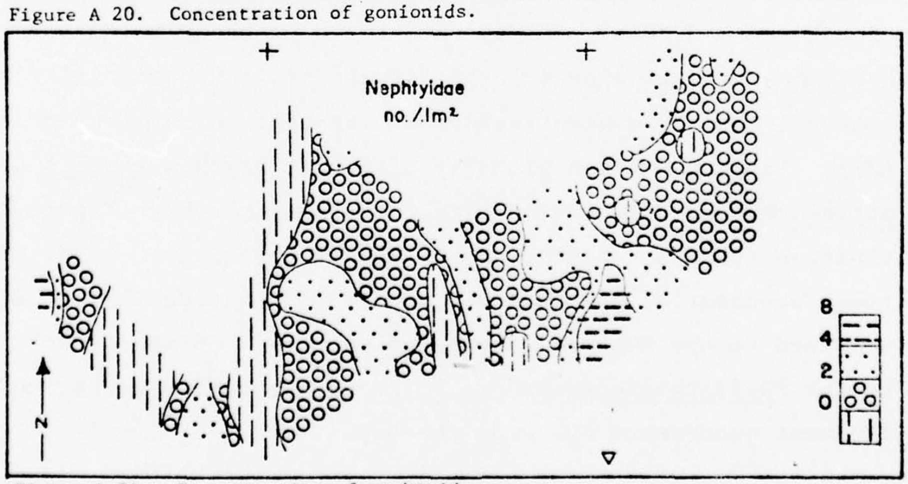

Figure A 21. Concnetration of nephtyids.

and *Goniadidae brunnea* and they appeared to prefer the eastern portion of the bay. Nephtyids and phyllodocids (Figures A21 and A22) showed no trends in distribution with *Nephtys ferruginea* and *Phyllodocidae williamsi* being the most frequently represented species.

Sedentarian Polychaetes

11. Highest concentrations of sedentarian polychaetes occurred in the eastern portion of the bay (figure A23). The maldanids (Figure A24) although having a large between-station variability, appeared to have higher concentrations in the eastern portion of the bay. *Euclymene zonalis* was the dominant maldanid followed by *Praxilella gracilis*, *P. affinis*, *Asychis similis*, *Maldane glebifex*, and *Myriochele heeri*. Capitellids (Figure A25) were most abundant in the eastern portion of the bay consisting mainly of *Heteromastus filobranchus*, *Capitella capitata*, the latter species dominates the upper portion of the Duwamish River, was rarely observed. Spionids (Figure A26) also appear to show an eastern bay preference; the dominant species were *Prionospio malmgreni* with lesser numbers of large specimens of *Laonice cirrata*. In general, both the sedentarian and errantian concentrations were low compared to concentrations reported by Richardson et al. 1977 and Lie 1968.

Empty Worm Tube Distribution

12. Most empty tubes found in the bay were sand tubes with lesser amounts of mud tubes. Empty sand tubes probably belonging to the maldanid *Euclymene zonalis* showed large between-station variability but were generally higher concentrations in the eastern portions of the bay (Figure A27). Large mud tubes probably of either *Asychis similis* or *Praxilella affinis* showed high variability throughout the bay (Figure A28). Pectinarian tubes are also frequent in the bay (Figure A29). Small brittle tubes abundant at the intermediate depths outside Elliott Bay were primarily confined to the western portion of the bay. Chitonous worm tubes belonging to the *Phyllochaetopterus prolifica* were rare in the bay compared to their frequent occurrence out side the bay.

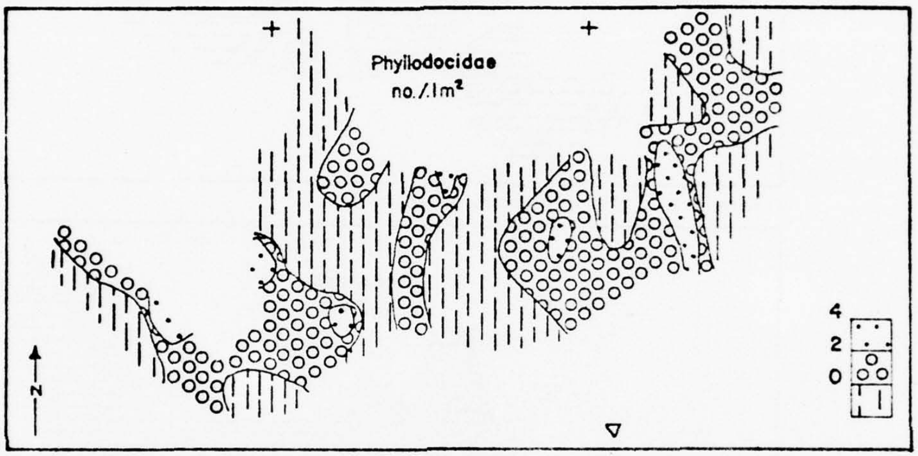

Figure A 22. Concentration of phyllodocids.

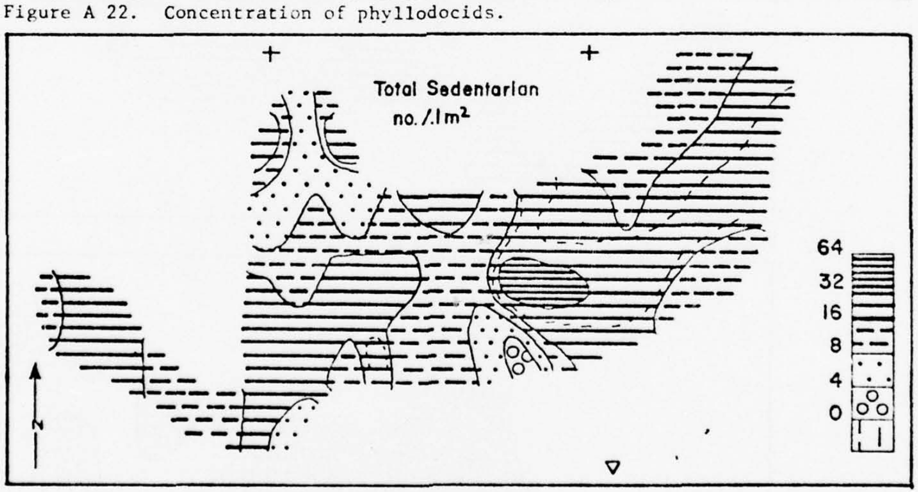

Figure A 23. Concentration of total sedentarians.

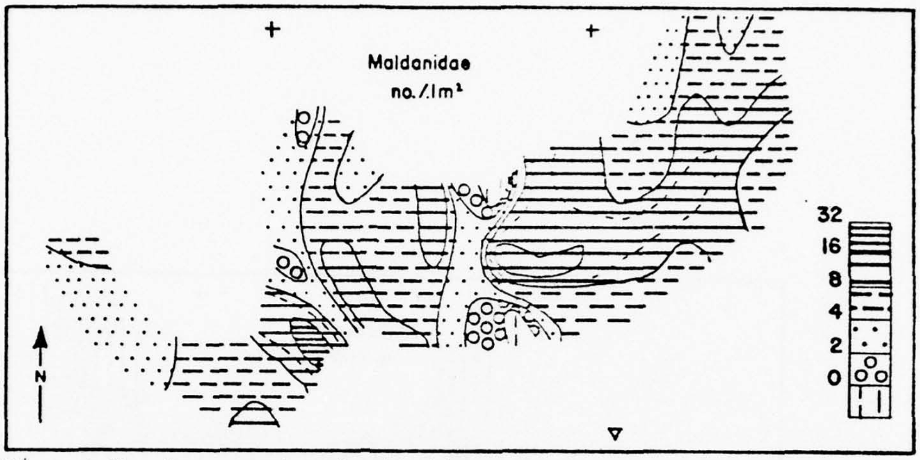

Figure A 24. Concentration of maldanids.

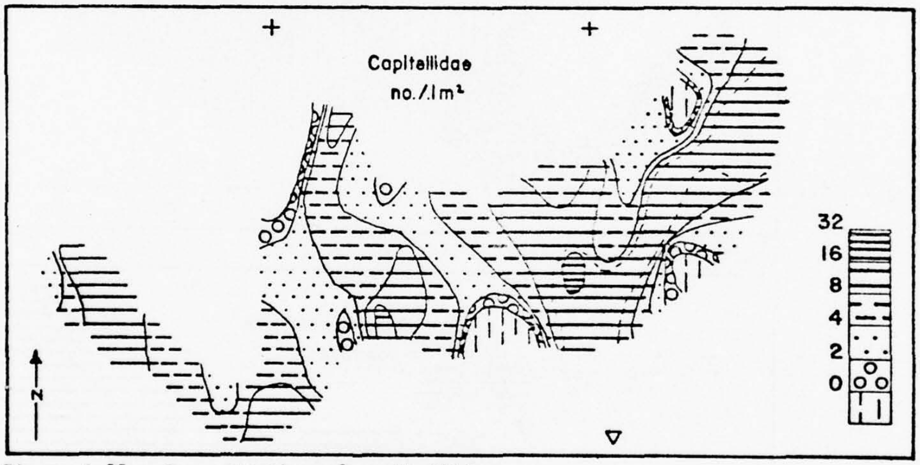

Figure A 25. Concentration of capitellids.

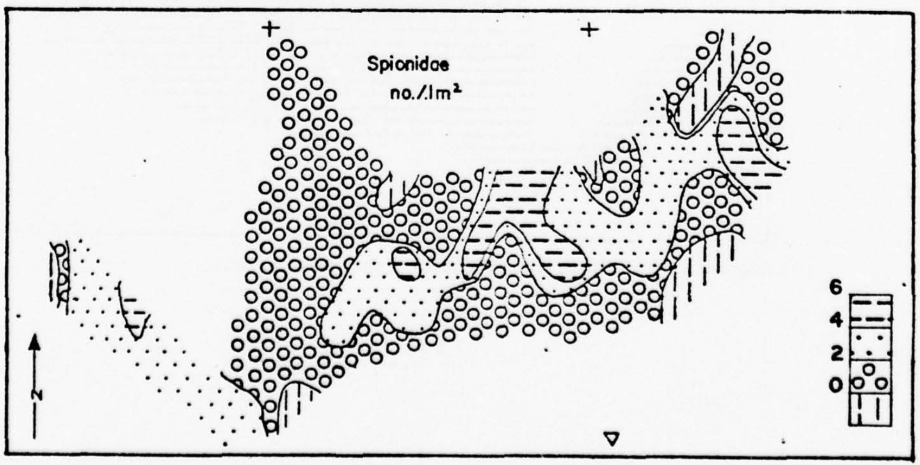

Figure A 26. Concentration of spionids.

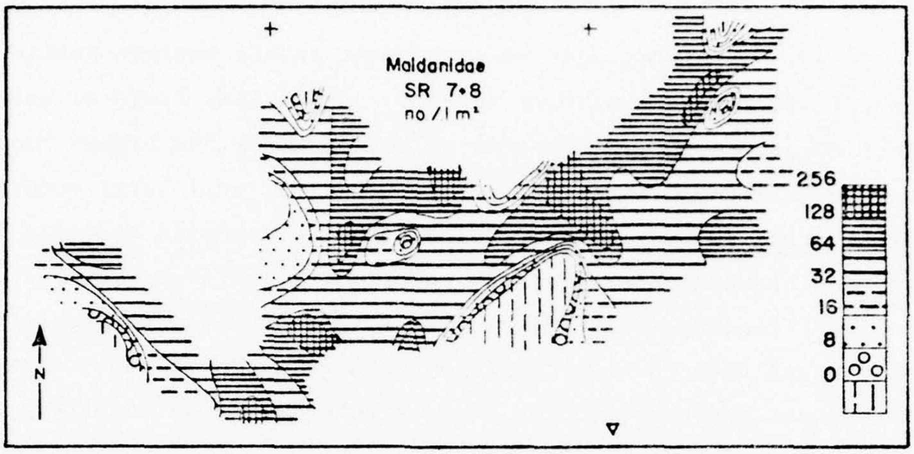

Figure A 27. Concentration of maldanid tube type SR 7 and 8.

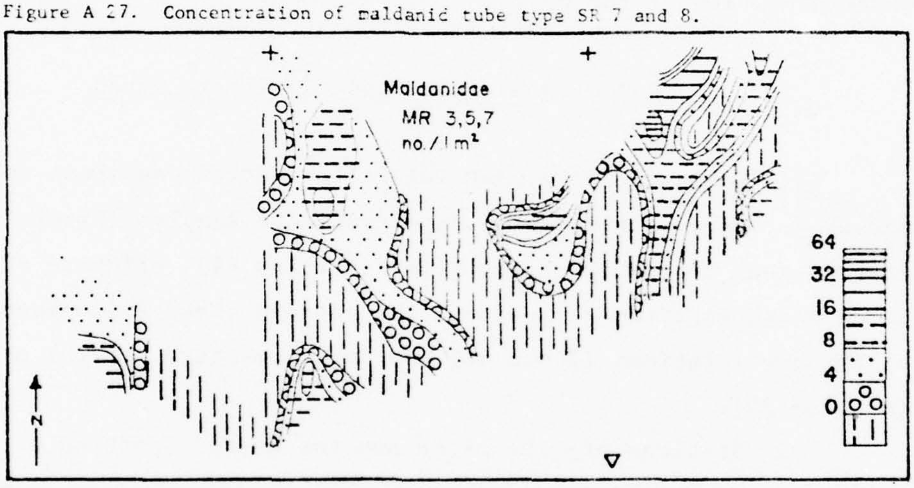

Figure 28. Concentration of maldanid tube types MR 3, 5, 7.

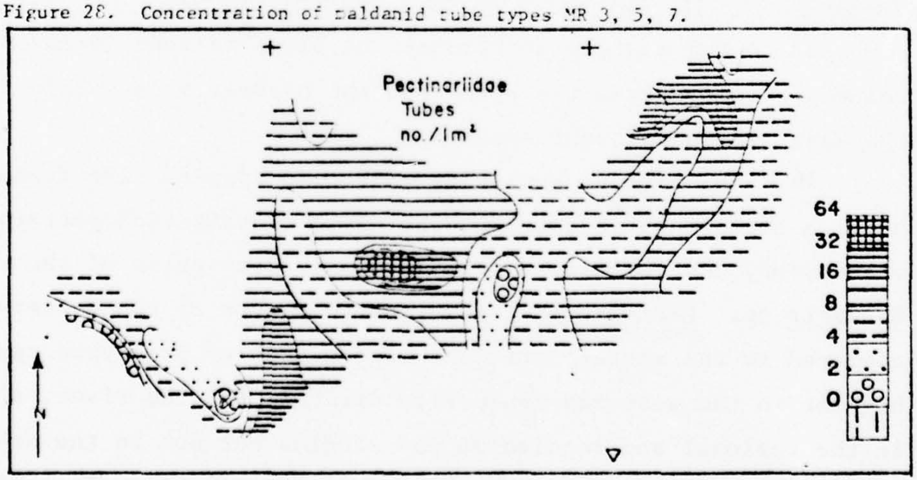

Figure A 29. Concentration of pectinarian tubes.

Other Macrofaunal Components

13. Amphipods were most abundant in the western portion of the bay, especially in the shallower samples. Other less frequent crustaceans were cumaceans and tanadaceans which seemingly had higher concentrations on the western portion of the bay. An occasional large nemertean, Cerebratula sp. was sampled. The large holothuroid Molpadia intermedia and the heart urchin Brisaster townsendi were rarely sampled in contrast to their frequent occurence in the deeper habitats (greater than 100 m) of central Puget Sound. Brittle stars were sporadically distributed throughout the bay with the highest concentrations occurring in the western portion of the bay.

Comparison Pilot Study Replicate Sites

14. Table A1 lists mean values for various sediment and faunal measures. Five stations with five replicate samples (Figure A1) were located near the mouth of the river (station 44), offshore from the river mouth (station 21), within the eastern river influenced portion of the bay (stations 17 and 44) and in the western portion of the bay (station 25).

15. Stations off the river and the western portion of the bay (Station 25, 21, 44) had high sand content and volume of rock residue compared to the eastern portion of the bay (stations 14 and 4). Wood volumes offshore from the river had the highest value while those on the west side had lowest amounts.

16. The highest number of gastropod species were found on the west side, a trend substantiated by the areal distribution patterns of the pilot study and verified by the recolonization pahse of the study. Barleeia sp. Mitrella gouldi were both higher at the western station compared to the eastern station. The number of pelecypod species are highest in the west and shore site directly off the river, a trend observed in the regional and recolonization studies but not in the areal plots of the pilot study. Although the areal distribution plots of the pilot

Table A-1

Comparison of Averages for Replicate Stations of Pilot Study*

	Sta. 25	Sta. 21	Sta. 44	Sta. 17	Sta. 47
% Sand	74.0	75.0	73.0	49.0	45.0
Volume Rock	88.8	90.0	55.0	16.0	26.0
Volume Wood & Fiber	10.0	93.0	25.0	32.0	25.0
Number Gastropod Species	3.3	1.4	2.0	1.7	2.0
Mitrella gouldi	2.7	1.0	1.0	.6	.6
Barleeia sp.	2.3	1.5	.6	1.0	.2
Number Pelecypod Species	8.3	3.0	8.4	4.4	6.0
Axinopsida serricata	99.0	79.0	68.4	169.8	100.0
Macoma carlottensis	22.0	5.6	8.0	11.8	6.2
Nuculata minuta	5.7	1.1	2.6	.2	1.2
Nemocardium centifilosum	1.3	.3	2.0	0.0	0.0
Nucula tenuis	16.0	.4	11.6	2.0	1.4
Total Errantean Specimens	7.4	3.6	9.0	8.7	5.0
Lumbrineridae	2.6	1.1	2.2	3.2	2.0
Onuphidae	1.6	.3	.2	1.8	1.2
Glyceridae	2.0	.9	2.4	1.2	.8
Goniadidae	.6	.3	.4	.6	.4
Nephtyidae	1.0	.3	1.6	1.6	1.0
Phyllodocidae	1.3	.6	.2	1.2	1.0
Maldanidae	3.7	1.7	2.6	7.8	4.4
Capitellidae	8.8	1.6	7.0	2.5	4.0
Spionidae	1.5	.4	1.8	2.8	1.4
Total Sedentarian	15.6	4.0	12.6	20.5	10.0
SR7-8	102.7	10.4	36.0	105.8	55.2
MR3-5-7	5.7	1.7	2.4	9.6	17.6
Pectinaridae	4.0	8.0	6.0	6.0	16.0

Note: Station locations: 25, west side of bay; 21, offshore near river mouth; 44, inshore near river; 17, offshore east side of bay; 47, offshore east side of bay.

*Comparison of mean values of sediment and faunal component data of the pilot study replicate sites.

study did not indicate east-west differences in Axinopsida serricata, replicate stations showed their greater abundance at the eastern sites. As the earlier regional studies indicated and phase 2 and 4 results of this study show, Macoma carlottensis, Nucula tenuis and M. moesta alaskana have higher values in the western portion of the bay. However, these studies also indicated that the western portion of the bay were typically represented by the pelecypods Nuculana minuta and Nemocardium centifilosum.

17. Total errantian concentrations were more numerous in sites more influenced by immediate river sedimentation (stations 17 and 44). However, both the earlier regional distribution study and phase 2 and 4 results indicated a greater frequency of errantians in the western portion of the bay. Dominant errantian worm species occurring within the eastern portion of the bay were Lumbrineris luti, Nephtys ferruginea, and Onuphis iridescens, while Glycera capitata was the dominant predatory errantian in the western portion of the bay and nearest the river. In contrast, Phase 2 and 4 results suggest that Nephtys ferruginea is more frequent on the west side of the bay. Sedentarian polycahetes appear most frequently offshore and in the eastern bay area, although also abundant in the west and nearest the river. Maldanids and spionids appear to be most abundant in the eastern stations. The most abundant capitellid, Heteromastus filobranchus, showed a higher concentration on the west and inshore of the river, a trend not verified by Phase 2 and 4 data. Although worm tubes primarily belonging to Euclymene zonalis (SR7-8) were abundant east and west, Phase 2 and 4 results suggest their preference for the western site. Large mud tubes most likely belonging to Praxilella affinis were most abundant in the eastern stations, a trend substantiated by Phase 2 and 4 data. Pectinarian tubes most likely belonging to Pectinaria californiensis were abundant in the east, again verified by Phase 2 and 4 distribution plots. Both the river and the western stations contained more of the numerous small rigid brittle sand tubes (SR-1 and SR-10) compared to the eastern stations.

Basis for selection of reference and experimental disposal stations

18. We recommend that the experimental disposal site be located directly off the mouth of the river in deeper water. This site should show the influences of the river as well as the eastern and western bay influences on the recolonization of the disposal sites. Those species that were more dominant on the eastern site should prove to be more tolerant of the disposal activity and the river-influenced species should be the first to reoccupy the site. In contrast, those species that typify the western site should be more impacted or last to reoccupy the disposal site especially those that preferred habitats outside Elliott Bay. Both the east and western references sites should be located within the southern portion of Elliott Bay, since faunas in habitats outside Elliott Bay are not representative. In addition, the eastern site should document the effects of the river-suspended load while the western site should be able to detect expatriated fauna and seasonal influences from the Duwamish Head area.

Summary

19. The following conclusions can be drawn from the results of the pilot study:

a. The western side of the bay is more species rich in pelecypods and gastropods.

b. Pilot studies should be conducted during the summer months when annuals increase concentrations or recruitment patterns.

c. Pilot studies should make an effort to show regional trends in concentrations of species so that seasonal monitoring stations can be located to assess spatial heterogeneity and productivity factors.

d. Both an east and west reference site should be selected in order to best document the effects of expatraition of faunas from outside Elliott Bay and to assess the role of river sedimentation influence on the changes of the macrofauna.

e. In this area a deeper, offshore river replicate site would be the best site for an experimental disposal study because of its more equidistant location from river, western and eastern bay influences.

Annelida and Mollusca clarification

Entries without parentheses indicate density in number per square metre.
Entries enclosed in parentheses indicate wet weight in milligrams per square metre.

Sediment analysis abbreviations:

ND - No Data
G - Green
g - grey
B - Brown
b - black
Lt - light
dk - dark

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- PHYLUM
  - CLASS
    - SUBCLASS
      - ORDER
        - FAMILY
          - SPECIES

- Annelida
  - Polychaeta
    - Errantia
      - Arabellidae
        - Notocirrus californiensis
      - Dorvilleidae
      - Glyceridae
        - Glycera americana
        - Glycera capitata
        - Glycera tesselata
      - Goniadidae
        - Glycinde armigera
        - Glycinde picta
        - Goniada brunnea
      - Hesionidae
      - Lumbrineridae
        - Lumbrineris bicirrata
        - Lumbrineris bifurcata
        - Lumbrineris luti
        - Lumbrineris zonata
        - Ninoe gemmea
      - Nephtyidae
        - Nephtys californiensis
        - Nephtys ferruginea
      - Nereidae
        - Nereis procera
      - Onuphidae
        - Onuphis iridescens
        - Diopatra ornata
      - Phyllodocidae
        - Eteone sp.
        - Eteone longa
        - Phyllodoce multiseriata
        - Phyllodoce groenlandica
        - Phyllodoce williamsi
        - Phyllodoce medipedipalpa
        - Planktonic phyllodocidae
        - Eulalia leuicornuta
      - Polydontidae
        - Peisidice aspera
      - Polynoidae
        - Gattyana treadwelli
        - Harmothoe imbricata
        - Unknown Polynoids
      - Sigalionidae
        - Pholoe minuta
      - Sphaerodoridae
        - Sphaerodoropsis sphaerulifer
      - Syllidae
        - Syllis harti
        - Unknown syllids
    - Sedentaria
      - Ampharetidae
        - Amphicteis scaphobranchiata
        - Ampharete goesi
        - Melinna cristata
      - Arenicolidae
        - Abarenicola pacifica
      - Capitellidae
        - Capitella capitata
        - Heteromastus cf filobranchus
        - Mediomastus californiensis
        - Notomastus cf tenuis
      - Chaetopteridae
        - Spiochaetopterus costarum
        - (Telepsavus costarum)
      - Cirratulidae
        - Cirratulus cirratus
        - Chaetozone setosa
        - Tharyx sp.

- Sedentaria con't
  - Cossuridae
    - Unknown sp.
  - Disomidae
    - Trochochaeta multisetosa
  - Flabelligeridae
  - Magelonidae
    - Magelona japonica
  - Maldanidae
    - Asychis similis
    - Euclymene zonalis
    - Maldane glebifex
    - Nicomache lumbricalis
    - Praxilella affinis
    - Praxilella gracilis
    - Rhodine bitorquata
  - Opheliidae
    - Ammotrypane aulogaster
    - Armandia brevis
    - Travisia brevis.
    - Travisis pupa
  - Orbiniidae
    - Haploscoloplos elongata
    - Scoloplos armiger
  - Oweniidae
    - Myriochele heeri
    - Owenia fusiformis
  - Paraonidae
    - Paraonella spinifera
    - Aricidea (longicornuta)quadrilobata
  - Pectinariidae
    - Pectinaria californiensis
    - Pectinaria (cistenides) granulata
  - Pilargidae
    - Unknown sp.
  - Sabellidae
    - Megalomma splendida
    - Unknown sabellids
  - Serpulidae
    - Crucigera zygophora
  - Spionidae
    - Laonice cirrata
    - Prionospio malmgreni (sterstrupi)
    - Prionospio pinnata
    - Polydora cardalia
    - Polydora uncata
  - Sternaspidae
    - Sternaspis scutata
    - Sternapis fossor
  - Terebellidae
    - Artacama conifera
    - Terebellidae sp.
    - Pista cristata
  - Trichobranchidae
    - Terebellides stroemi
    - Trichobranchus glacialis

PHYLUM
CLASS
SUBCLASS
ORDER
FAMILY
SPECIES

Mollusca
Gastropoda
Prosobranchia
Barleeia sp.
Bittium subplanatum
Colisella digitalis
Crepidula sp.
Lacuna sp.
Littorina sp.
Margarites sp.
Mitrella gouldi
Nassarius mendicus
Natica clausa
Oenopota sp.
Oenopota elegans
Olivella sp.
Polinices lewisii
Thais sp.
Thais canaliculata
Thais lamellosa
Trichotropis cancellata

Opisthobranchia
Odostomia sp.
Turbonilla sp.
Haminoea vesicula

Pelecypoda
Acetocemia exima
Ascila castrensis
Astarte alaskensis
Axinopsida serricata
Cardiomya oldroydi
Cardita ventricosa
Clinocardium nuttalli
Compsomyax subdiaphana
Glycymeris subobsoleta
Hiatella pholadis
Kurtziella plumbea
Lucinoma annulata
Lucinoma tenuisculpta
Lysonia californica
Lysonia pugettensis
Macoma alaskansis
Macoma carlottensis
Macoma nasuta
Macoma secta
Macoma inquinata
Megacrenella columbiana
Modiolus rectus
Mytilus edulis
Nemocardium centifilosum
Nucula tenuis
Nuculana minuta
Pandora filosa
Paravalucina tenuisculptis
Protothaca staminea
Psephidia lordi
Saxicava arctica

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 3 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: x̄	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: x̄	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: x̄	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: x̄
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Errantia																	
Arrabellidae	Notocirrus californiensis										1.0 (.192)		0.33 (.0640)				
Glyceridae	Glycera capitata	4.0 (.300)	3.0 (.032)		2.33 (.1107)	2.0 (.048)	2.0 (.003)	1.0 (.002)	1.67 (.0177)	1.0 (.008)	1.0 (.003)	7.0 (.040)	3.0 (.0170)	4.0 (.086)	4.0 (.005)	4.0 (.165)	4.0 (.0853)
Goniadidae	Glycinde picta	1.0 (.013)	4.0 (.215)	2.0 (.008)	2.33 (.0786)						2.0 (.010)	1.0 (.010)	1.0 (.0067)	2.0 (.012)	1.0 (.020)	3.0 (.006)	2.0 (.0127)
Lumbrineridae	Lumbrineris luti	6.0 (.030)	9.0 (.082)	1.0 (.009)	5.33 (.0403)	2.0 (.003)	2.0 (.010)	1.0 (.003)	1.67 (.0053)	1.0 (.007)	3.0 (.010)	4.0 (.026)	2.67 (.0143)	1.0 (.008)	1.0 (.005)		0.67 (.0043)
	Lumbrineris zonata															5.0 (.012)	1.67 (.0040)
	Ninoe gemma													1.0 (.028)			0.33 (.0093)
Nephtyidae	Nephtys ferruginea	8.0 (.032)	9.0 (.152)	5.0 (.032)	7.33 (.0720)	2.0 (.023)	3.0 (.004)	3.0 (.019)	2.67 (.0153)		2.0 (.003)	13.0 (.072)	5.0 (.0250)	4.0 (.016)	2.0 (.017)	1.0 (.015)	2.33 (.0160)
Onuphidae	Onuphis iridescens	1.0 (.014)			0.33 (.0047)									1.0 (.007)	1.0 (.340)		0.67 (.1157)
Phyllodocidae	Eteone longa	2.0 (.006)	2.0 (.008)	6.0 (.028)	3.33 (.0140)		2.0 (.010)		0.67 (.0033)		1.0 (.006)	4.0 (.011)	1.67 (.0056)	1.0 (.114)		3.0 (.004)	1.33 (.0393)
	Phyllodoce williamsi					1.0 (.009)		1.0 (.004)	0.67 (.0043)			1.0 (.005)	0.33 (.0017)		1.0 (.020)		0.33 (.0067)
Polynoidae	Unknown sp.	1.0 (.012)			0.33 (.0040)	1.0 (.006)			0.33 (.0020)		1.0 (.018)		0.33 (.0060)				
Syllidae	Unknown sp.	1.0 (.001)			0.33 (.0003)						1.0 (.005)		0.33 (.0017)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum Class Subclass Order Family	Scientific Name	Station 1 1	 2	 3	 x̄	Station 2 1	 2	 3	 x̄	Station 3 1	 2	 3	 x̄	Station 4 1	 2	 3	 x̄
		Replicate and Mean Density and Biomass*															
Annelida Polychaeta Sedentaria																	
Ampharetidae	Amphicteis scaphobranchiata	1.0 (.003)	2.0 (.005)		1.0 (.0027)		3.0 (.005)		1.0 (.0017)	2.0 (.006)	1.0 (.005)	9.0 (.023)	4.0 (.0113)	16.0 (.038)	3.0 (.005)	3.0 (.004)	7.33 (.0157)
Capitellidae	Heteromastus cf. filobranchus	4.0 (.210)	2.0 (.132)	3.0 (.602)	3.0 (.3147)	1.0 (.107)	6.0 (.247)	14.0 (.056)	7.0 (.1367)	4.0 (.007)	2.0 (.020)	5.0 (.144)	3.67 (.0570)	5.0 (.515)	7.0 (.435)	7.0 (.078)	6.33 (.3427)
Cirratulidae	Chaetozone setosa		1.0 (.002)		0.33 (.0007)	1.0 (.003)	1.0 (.001)		0.67 (.0013)	1.0 (.007)		1.0 (.001)	0.67 (.0027)		1.0 (.001)		0.33 (.0003)
Cossuridae	Unknown sp.	1.0 (.001)	1.0 (.001)		0.67 (.0007)		1.0 (.001)	1.0 (.001)	0.67 (.0007)	2.0 (.002)			0.67 (.0007)			1.0 (.001)	0.33 (.0003)
Disomidae	Trochochaeta multisetosa		1.0 (.003)		0.33 (.0010)						1.0 (.003)	2.0 (.010)	1.0 (.0043)	2.0 (.009)	1.0 (.001)		1.0 (.0033)
Flabelligeridae	Unknown sp.													1.0 (.010)			0.33 (.0033)
Maldanidae	Euclymene zonalis	13.0 (.238)	6.0 (.208)	17.0 (.479)	12.0 (.3083)						3.0 (.055)	6.0 (.120)	3.0 (.0583)	7.0 (.155)	3.0 (.065)	5.0 (.134)	5.0 (.1180)
	Praxillella gracilis	1.0 (.093)	1.0 (.010)		0.67 (.0343)							1.0 (.070)	0.33 (.0233)			1.0 (.050)	0.33 (.0167)
Opheliidae	Ammotrypane aulogaster	2.0 (.003)		2.0 (.052)	1.33 (.0183)		1.0 (.037)	4.0 (.157)	1.67 (.0647)	1.0 (.038)	3.0 (.108)	4.0 (.003)	2.67 (.0497)	1.0 (.001)	2.0 (.051)	2.0 (.068)	1.67 (.0400)
Oweniidae	Myriochele heeri			1.0 (.003)	0.33 (.0010)									1.0 (.008)	1.0 (.003)		0.67 (.0037)
	Owenia fusiformis										2.0 (.008)	1.0 (.005)	1.0 (.0043)		2.0 (.008)	1.0 (.008)	1.0 (.0053)
Paraonidae	Aricidea longicornuta		3.0 (.012)	1.0 (.002)	1.33 (.0047)		4.0 (.005)		1.33 (.0017)	1.0 (.002)	1.0 (.001)	3.0 (.004)	1.67 (.0023)	2.0 (.003)			0.67 (.0010)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Paraonidae	Paraonella spinifera	4.0 (.006)	2.0 (.002)		2.0 (.0027)									1.0 (.001)	4.0 (.003)	1.0 (.001)	2.0 (.0017)
Spionidae	Polydora uncata	2.0 (.009)	2.0 (.022)	2.0 (.027)	2.0 (.0193)	4.0 (.052)	8.0 (.085)	17.0 (.235)	9.67 (.1240)		1.0 (.085)	3.0 (.010)	1.33 (.0050)	1.0 (.008)	3.0 (.021)		1.33 (.0097)
	Laonice cirrata	1.0 (.205)	1.0 (.110)	1.0 (.082)	1.00 (.1323)	1.0 (.219)			0.33 (.0730)	1.0 (.139)	1.0 (.010)	2.0 (.012)	1.33 (.0537)	3.0 (.527)	1.0 (.665)	1.0 (.488)	1.67 (.5600)
	Prionospio malmgreni	11.0 (.015)		8.0 (.058)	6.33 (.0243)	2.0 (.005)	3.0 (.007)	5.0 (.011)	3.33 (.0077)	2.0 (.015)		8.0 (.016)	3.33 (.0103)	8.0 (.018)	6.0 (.020)	1.0 (.003)	5.00 (.0137)
	Prionospio cirrata											1.0 (.002)	0.33 (.0007)				
	Spionophanes cirrata		1.0 (.010)		0.33 (.0033)												
Terebellidae	Artacama conifera			3.0 (.240)	1.00 (.0080)							3.0 (.105)	1.00 (.0350)	3.0 (.080)	1.0 (.023)	1.0 (.039)	1.67 (.0473)
Trichobranchidae	Terebellides stroemi		2.0 (.022)	3.0 (.109)	1.67 (.0437)					2.0 (.042)			0.67 (.0140)	1.0 (.007)	4.0 (.025)		1.67 (.0107)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.	2.0 (.005)			0.67 (.0017)			1.0 (.003)	0.33 (.0010)					9.0 (.024)	1.0 (.002)		3.33 (.0087)
	Mitrella gouldi		4.0 (.513)		1.33 (.1710)						1.0 (.011)	1.0 (.003)	0.67 (.0047)	3.0 (.087)	1.0 (.003)		1.33 (.0300)
Opisthobranchia	Haminoea vesicula		1.0 (.003)		0.33 (.0010)			1.0 (.005)	0.33 (.0017)								
	Pteropod		1.0 (.155)		0.33 (.0517)						1.0 (.132)		0.33 (.0440)				
Pelecypoda (Bivalvia)	Ascila castrensis											1.0 (.034)	0.33 (.0113)	1.0 (.557)			0.33 (.1857)
	Axinopsida serricata	131.0 (1.064)	121.0 (1.280)	116.0 (.818)	122.67 (1.0540)	11.0 (.091)	1.0 (.002)	4.0 (.039)	5.33 (.0440)	21.0 (.175)	32.0 (.234)	129.0 (.918)	60.67 (.4423)	246.0 (1.726)	30.0 (.304)	17.0 (.118)	97.67 (.7160)
	Macoma alaskansis		2.0 (.674)		0.67 (.2247)					3.0 (.059)		4.0 (.434)	2.33 (.1643)	1.0 (.019)		1.0 (.011)	0.67 (.0100)
	Macoma carlottensis	6.0 (.096)	23.0 (.715)	3.0 (.131)	10.67 (.3140)	3.0 (.050)	6.0 (.005)	7.0 (.029)	5.33 (.0280)	3.0 (.009)	14.0 (.251)	7.0 (.159)	8.00 (.1397)	26.0 (.302)	15.0 (.078)	9.0 (.035)	16.67 (.1383)
	Nemocardium centifilosum										1.0 (.001)		0.33 (.0003)				
	Nuculana minuta	1.0 (.004)		2.0 (.046)	1.0 (.0167)					1.0 (.014)	2.0 (.104)	1.0 (.010)	1.33 (.0427)	1.0 (.003)			0.33 (.0010)
	Nucula tenuis			1.0 (.015)	0.33 (.0050)		1.0 (.008)	1.0 (.047)	0.67 (.0183)	1.0 (.069)	2.0 (.024)	3.0 (.013)	2.00 (.0353)	3.0 (.037)	3.0 (.026)	2.0 (.023)	2.67 (.0287)
	Yoldia sissurata			1.0 (.545)	0.33 (.1817)												
**Opisthobranchia	Odostomia sp.														2.0 (.007)		0.67 (.0023)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

		Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA																	
	Density	24.0	27.0	14.0	21.64	8.0	9.0	6.0	7.68	2.0	12.0	30.0	14.66	14.0	10.0	16.0	13.33
	Biomass	.408	.489	.077	.3246	.089	.027	.028	.0479	.0150	.2470	.1640	.1420	.2710	.4070	.2020	.2933
	Number of species	8.0	5.0	4.0	5.67	5.0	4.0	4.0	4.33	2.0	8.0	6.0	5.33	7.0	6.0	5.0	6.00
SEDENTARIA	Density	40.0	25.0	41.0	35.32	9.0	27.0	41.0	25.67	16.0	15.0	49.0	26.67	52.0	39.0	24.0	38.33
	Biomass	.783	.539	1.654	.9920	.386	.388	.460	.4115	.258	.215	.525	.3326	1.380	1.326	.874	1.1934
	Number of species	10.0	13.0	10.0	11.00	5.0	8.0	5.0	6.00	9.0	9.0	14.0	10.67	14.0	14.0	11.0	13.00
GASTROPODA	Density	2.0	6.0		2.66			2.0	0.66		2.0	1.0	1.00	12.0	4.0		5.33
	Biomass	.005	.671		.2254			.008	.0027		.143	.003	.0487	.111	.012		.0410
	Number of species	1.0	3.0		1.33			2.0	0.67		2.0	1.0	1.00	2.0	3.0		1.67
PELECYPODA	Density	138.0	146.0	123.0	135.67	14.0	8.0	12.0	11.33	29.0	51.0	145.0	74.99	278.0	48.0	29.0	118.34
	Biomass	1.164	2.669	1.555	1.7961	.141	.015	.115	.0903	.326	.614	1.568	.8359	2.664	.408	.187	1.0797
	Number of species	3.0	3.0	5.0	3.67	2.0	3.0	3.0	2.67	5.0	5.0	6.0	5.33	6.0	3.0	4.0	4.33
TOTAL	Density	204.0	204.0	178.0	195.29	31.0	44.0	61.0	45.34	47.0	80.0	225.0	117.32	356.0	101.0	69.0	175.33
	Biomass	2.360	4.368	3.286	3.3381	.616	.430	.611	.5524	.599	1.219	2.260	1.3592	4.426	2.153	1.263	2.6074
	Number of species	22.0	24.0	19.0	21.67	12.0	15.0	14.0	13.67	16.0	24.0	27.0	22.33	29.0	26.0	20.0	25.00

5

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	3.0 (.013)		2.0 (.242)	1.67 (.0850)	5.0 (.015)	4.0 (.012)	3.0 (.022)	4.0 (.0163)		3.0 (.009)		1.0 (.0030)	3.0 (.038)	4.0 (.015)	4.0 (.012)	3.67 (.0217)
Goniadidae	Glycinde picta			1.0 (.002)	0.33 (.0007)	2.0 (.185)	4.0 (.060)		2.0 (.0883)		9.0 (.075)		3.0 (.0250)			3.0 (.010)	1.0 (.0033)
Lumbrineridae	Lumbrineris luti			1.0 (.010)	0.33 (.0033)	4.0 (.020)	2.0 (.004)	3.0 (.014)	3.0 (.0127)					4.0 (.015)	2.0 (.009)	4.0 (.012)	3.33 (.0120)
Nephtyidae	Nephtys ferruginea	1.0 (.002)	2.0 (.004)	6.0 (.092)	3.0 (.0327)	4.0 (.008)		2.0 (.003)	2.0 (.0037)		5.0 (.015)		1.67 (.0050)	5.0 (.073)	4.0 (.032)	2.0 (.006)	3.67 (.0370)
Onuphidae	Onuphis iridescens	1.0 (.011)			0.33 (.0037)						1.0 (.006)		0.33 (.0020)	1.0 (.092)		1.0 (.072)	0.67 (.0547)
Phyllodocidae	Eteone longa	1.0 (.004)	1.0 (.002)	2.0 (.010)	1.33 (.0053)	3.0 (.006)	1.0 (.002)	1.0 (.002)	1.67 (.0033)					1.0 (.003)		3.0 (.004)	1.33 (.0023)
	Phyllodoce medipedipalpa						1.0 (.003)		0.33 (.0010)								
	Phyllodoce williamsi	1.0 (.015)			0.33 (.0050)	3.0 (.068)	1.0 (.038)	1.0 (.006)	1.67 (.0373)		4.0 (.043)		1.33 (.0143)				
	Planktonic phyllodocidae													1.0 (.010)			0.33 (.0033)
Polynoidae	Unknown sp.										1.0 (.022)		0.33 (.0073)				

6

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5				Station 6				Station 7				Station 8			
		Replicate and Mean Density and Biomass*															
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Amphicteis scaphobranchiata			1.0 (.019)	0.33 (.0063)	4.0 (.008)		1.0 (.002)	1.67 (.0033)		3.0 (.013)		1.0 (.0043)	4.0 (.002)	4.0 (.006)	2.0 (.004)	3.33 (.0040)
Capitellidae	Heteromastus cf. filobranchus	3.0 (.040)	3.0 (.032)		2.0 (.0240)	4.0 (.048)	9.0 (.493)	6.0 (.059)	6.33 (.2000)					6.0 (.420)	10.0 (.538)	10.0 (.274)	8.67 (.4107)
Cirratulidae	Cirratulus cirratus					1.0 (.005)			0.33 (.0017)						1.0 (.002)		0.33 (.0007)
	Chaetozone setosa															1.0 (.007)	0.33 (.0023)
Cossuridae	Unknown sp.	1.0 (.001)	3.0 (.003)		1.33 (.0013)			1.0 (.001)	0.33 (.0003)						2.0 (.001)	2.0 (.003)	1.33 (.0013)
Disomidae	Trochochaeta multisetosa		1.0 (.004)		0.33 (.0013)	1.0 (.004)	1.0 (.003)	2.0 (.013)	1.33 (.0067)					2.0 (.009)	2.0 (.010)	2.0 (.008)	2.0 (.0090)
Maldanidae	Euclymene zonalis			8.0 (.158)	2.67 (.0527)	6.0 (.076)			2.0 (.0253)					5.0 (.063)	1.0 (.005)	1.0 (.001)	2.33 (.0230)
	Praxillella gracilis														1.0 (.328)		0.33 (.1093)
Opheliidae	Ammotrypane aulogaster	6.0 (.162)		2.0 (.042)	2.67 (.0680)	1.0 (.001)	3.0 (.088)	3.0 (.070)	2.33 (.0530)		17.0 (.276)		5.67 (.0920)				
Orbiniidae	Haploscoloplos elongata		1.0 (.002)		0.33 (.0007)												
Oweniidae	Owenia fusiformis							1.0 (.004)	0.33 (.0013)								
Paraonidae	Aricidea longicornuta	3.0 (.004)			1.00 (.0013)	2.0 (.008)			0.67 (.0027)					1.0 (.002)	1.0 (.003)	4.0 (.008)	2.00 (.0043)
	Paraonella spinifera			1.0 (.001)	0.33 (.0003)	2.0 (.003)			0.67 (.0010)						2.0 (.007)	2.0 (.007)	1.33 (.0047)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5: 1	Station 5: 2	Station 5: 3	Station 5: $\bar{x}$	Station 6: 1	Station 6: 2	Station 6: 3	Station 6: $\bar{x}$	Station 7: 1	Station 7: 2	Station 7: 3	Station 7: $\bar{x}$	Station 8: 1	Station 8: 2	Station 8: 3	Station 8: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Sedentaria																	
Pectinariidae	Pectinaria californiensis							1.0 (.061)	0.33 (.0203)								
Spionidae	Polydora uncata	6.0 (.078)	3.0 (.028)	16.0 (.285)	8.33 (.1303)	13.0 (.162)	7.0 (.057)	6.0 (.044)	8.67 (.0877)		41.0 (.362)		13.67 (.1207)			14.0 (.174)	4.67 (.0580)
	Laonice cirrata					1.0 (.008)			0.33 (.0027)								
	Prionospio malmgreni	4.0 (.006)		2.0 (.007)	2.00 (.0043)	5.0 (.015)	3.0 (.015)	1.0 (.004)	3.00 (.0113)					4.0 (.009)	3.0 (.007)	9.0 (.028)	5.33 (.0147)
	Spionophanes cirrata					1.0 (.007)			0.33 (.0023)								
Terebellidae	Artacama conifera	1.0 (.335)			0.33 (.1117)	1.0 (.030)			0.33 (.0100)		2.0 (.068)		0.67 (.0227)		1.0 (.034)		0.33 (.0113)
Trichobranchidae	Terebellides stroemi										1.0 (.007)		0.33 (.0023)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.						2.0 (.005)		0.67 (.0017)						1.0 (.003)		0.33 (.0010)
	Mitrella gouldi										1.0 (.092)		0.33 (.0307)				
	Natica clausa	1.0 (.048)			0.33 (.0160)												
Opisthobranchia	Haminoea vesicula	1.0 (.003)			0.33 (.0010)		1.0 (.001)		0.33 (.0003)								
	Odostomia sp.														1.0 (.001)		0.33 (.0003)
Pelecypoda (Bivalvia)	Axinopsida serricata	9.0 (.023)	3.0 (.004)	10.0 (.093)	7.33 (.0400)	14.0 (.122)	2.0 (.011)	3.0 (.007)	6.33 (.0467)		4.0 (.003)	3.0 (.001)	2.33 (.0013)	8.0 (.065)	6.0 (.017)	7.0 (.035)	7.0 (.0390)
	Macoma alaskansis	1.0 (.031)			0.33 (.0103)	3.0 (.177)			1.0 (.0590)								
	Macoma carlottensis	4.0 (.031)	8.0 (.015)	6.0 (.016)	6.0 (.0207)	8.0 (.028)	8.0 (.032)	4.0 (.005)	6.67 (.0217)	9.0 (.006)	11.0 (.032)	10.0 (.034)	10.0 (.0240)	4.0 (.052)	9.0 (.012)	14.0 (.066)	9.0 (.0433)
	Nemocardium centifilosum										1.0 (.031)		0.33 (.0103)				
	Nucula tenuis	1.0 (.007)	2.0 (.019)		1.0 (.0087)											2.0 (.007)	0.67 (.0023)

9

Table

<u>Density and Biomass of Benthic Assemblages, Elliott Bay</u>

<u>Sampled 8 December 1976</u>

		Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	7.0	3.0	12.0	7.32	21.0	13.0	10.0	14.67		23.0		7.66	15.0	10.0	17.0	14.00
	Biomass	.045	.006	.356	.1357	.302	.139	.047	.1626		.170		.056	.231	.056	.116	.1343
	Number of species	5.0	2.0	5.0	4.00	6.0	6.0	5.0	5.67		6.0		2.00	6.0	3.0	6.0	5.00
SEDENTARIA	Density	24.0	11.0	30.0	21.65	42.0	23.0	22.0	28.98		64.0		21.34	22.0	28.0	47.0	32.31
	Biomass	.626	.069	.512	.4022	.375	.656	.258	.4296		.726		.2420	.505	.941	.514	.6533
	Number of species	7.0	5.0	6.0	6.00	13.0	5.0	9.0	9.00		5.0		1.67	6.0	11.0	10.0	9.00
GASTROPODA	Density	2.0			0.66		3.0		1.00		1.0		0.33		2.0		0.66
	Biomass	.051			.0170		.006		.0020		.092		.0307		.004		.0013
	Number of species	2.0			0.67		2.0		0.67		1.0		0.33		2.0		0.67
PELECYPODA	Density	15.0	13.0	16.0	14.66	25.0	10.0	7.0	14.0	9.0	16.0	13.0	12.66	12.0	15.0	23.0	16.67
	Biomass	.092	.038	.109	.0797	.327	.043	.012	.1274	.006	.066	.035	.0356	.117	.029	.108	.0846
	Number of species	4.0	3.0	2.0	3.00	3.0	2.0	2.0	2.33	1.0	3.0	2.0	2.00	2.0	2.0	3.0	2.33
TOTAL	Density	48.0	27.0	58.0	44.29	88.0	49.0	39.0	58.65	9.0	104.0	13.0	41.99	49.0	55.0	87.0	63.64
	Biomass	.814	.113	.977	.6346	1.004	.844	.317	.7216	.006	1.054	.035	.3650	.853	1.030	.738	.8735
	Number of species	18.0	10.0	13.0	13.67	22.0	15.0	16.0	17.67	1.0	15.0	2.0	6.00	14.0	18.0	19.0	17.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera americana			1.0 (.210)	0.33 (.0700)	1.0 (.500)			0.33 (.1667)					2.0 (.900)			0.67 (.3000)
	Glycera capitata			1.0 (.001)	0.33 (.0003)	3.0 (.014)	1.0 (.004)	1.0 (.007)	1.67 (.0083)	4.0 (.012)	3.0 (.010)		2.33 (.0073)	4.0 (.010)	3.0 (.016)	4.0 (.010)	3.67 (.0120)
Goniadidae	Glycinde picta			1.0 (.013)	0.33 (.0043)	1.0 (.008)	1.0 (.010)	1.0 (.008)	1.0 (.0087)	2.0 (.016)		4.0 (.016)	2.0 (.0106)		1.0 (.178)	2.0 (.010)	1.0 (.0627)
Lumbrineridae	Lumbrineris bicirrata															3.0 (.023)	1.0 (.0077)
	Lumbrineris luti	1.0 (.008)		3.0 (.018)	1.33 (.0087)	1.0 (.003)			0.33 (.0010)					5.0 (.022)	1.0 (.006)	3.0 (.033)	3.0 (.0203)
Nephtyidae	Nephtys ferruginea	3.0 (.013)			1.0 (.0043)	1.0 (.005)	3.0 (.007)	2.0 (.010)	2.0 (.0073)	4.0 (.017)	4.0 (.016)	3.0 (.009)	3.67 (.0140)	9.0 (.045)	3.0 (.032)	4.0 (.011)	5.33 (.0293)
Onuphidae	Onuphis iridescens							1.0 (.315)	0.33 (.1050)							1.0 (.134)	0.33 (.0447)
Phyllodocidae	Eteone longa	1.0 (.003)			0.33 (.0010)		1.0 (.004)		0.33 (.0013)		1.0 (.002)		0.33 (.0007)	1.0 (.002)	3.0 (.003)	1.0 (.002)	1.67 (.0023)
	Phyllodoce williamsi	1.0 (.012)	1.0 (.010)	1.0 (.009)	1.0 (.0103)					7.0 (.157)			2.33 (.0523)				
Polynoidae	Unknown sp.							1.0 (.025)	0.33 (.0083)		1.0 (.012)		0.33 (.0040)			1.0 (.035)	0.33 (.0117)

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Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 9: 1	Station 9: 2	Station 9: 3	Station 9: $\bar{x}$	Station 10: 1	Station 10: 2	Station 10: 3	Station 10: $\bar{x}$	Station 11: 1	Station 11: 2	Station 11: 3	Station 11: $\bar{x}$	Station 12: 1	Station 12: 2	Station 12: 3	Station 12: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Amphicteis scaphobranchiata			1.0 (.002)	0.33 (.0007)		2.0 (.003)	1.0 (.007)	1.00 (.0033)	4.0 (.006)	1.0 (.001)	2.0 (.002)	2.33 (.0030)		2.0 (.005)	3.0 (.005)	1.67 (.0033)
Capitellidae	Capitella capitata			1.0 (.015)	0.33 (.0050)									1.0 (.004)			0.33 (.0013)
cf.	Heteromastus filobranchus	5.0 (.038)	4.0 (.022)	6.0 (.081)	5.00 (.0470)	11.0 (.044)	8.0 (.013)	3.0 (.036)	7.33 (.0310)	6.0 (.013)	2.0 (.006)	5.0 (.015)	4.33 (.0113)	3.0 (.102)	16.0 (.336)	13.0 (.230)	10.67 (.2227)
Cirratulidae	Cirratulus cirratus			1.0 (.007)	0.33 (.0023)												
	Chaetozone setosa										1.0 (.004)		0.33 (.0013)			1.0 (.002)	0.33 (.0007)
Disomidae	Trochochaeta multisetosa			1.0 (.002)	0.33 (.0007)	1.0 (.007)			0.33 (.0023)	2.0 (.007)	2.0 (.013)		1.33 (.0067)	5.0 (.012)		4.0 (.017)	3.00 (.0097)
Cossuridae	Unknown sp.	1.0 (.001)			0.33 (.0003)		1.0 (.001)		0.33 (.0003)							1.0 (.001)	0.33 (.0003)
Maldanidae	Euclymene zonalis					1.0 (.006)			0.33 (.0020)					9.0 (.128)		8.0 (.104)	5.67 (.0773)
	Praxillella gracilis	1.0 (.134)		1.0 (.080)	0.67 (.0713)											1.0 (.128)	0.33 (.0427)
Opheliidae	Ammotrypane aulogaster			2.0 (.030)	0.67 (.0100)	1.0 (.042)	2.0 (.035)	6.0 (.200)	3.00 (.0923)	10.0 (.204)	2.0 (.075)	5.0 (.072)	5.67 (.1170)	1.0 (.031)		1.0 (.001)	0.67 (.0107)
Paraonidae	Aricidea longicornuta	2.0 (.004)	2.0 (.004)	1.0 (.002)	1.67 (.0033)	1.0 (.004)	3.0 (.008)		1.33 (.0040)		1.0 (.003)		0.33 (.0010)	1.0 (.002)	1.0 (.002)	10.0 (.018)	4.00 (.0073)
	Paraonella spinifera						1.0 (.001)		0.33 (.0003)					1.0 (.001)	2.0 (.004)	3.0 (.005)	2.0 (.0033)
Pectinariidae	Pectinaria californiensis	1.0 (.005)		1.0 (.083)	0.67 (.0293)		1.0 (.016)		0.33 (.0053)			1.0 (.044)	0.33 (.0147)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria Spionidae	Polydora uncata	3.0 (.018)	1.0 (.010)	13.0 (.090)	5.67 (.0393)	6.0 (.025)	20.0 (.245)	9.0 (.092)	11.67 (.1207)	46.0 (.310)	36.0 (.285)	15.0 (.102)	32.33 (.2323)	16.0 (.065)		5.0 (.025)	7.0 (.0300)
	Laonice cirrata						1.0 (.008)		0.33 (.0027)		1.0 (.415)		0.33 (.1383)	2.0 (.228)	1.0 (.005)		1.0 (.0777)
	Prionospio malmgreni	4.0 (.011)	2.0 (.005)	1.0 (.005)	2.33 (.0070)	1.0 (.001)	4.0 (.009)	2.0 (.015)	2.33 (.0083)					7.0 (.015)	3.0 (.014)	1.0 (.002)	3.67 (.0103)
Terebellidae	Artacama conifera			1.0 (.032)	0.33 (.0107)	1.0 (.010)		2.0 (.274)	1.0 (.0947)								
Trichobranchidae	Terebellidae stroemi															1.0 (.014)	0.33 (.0047)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 9 — 1	Station 9 — 2	Station 9 — 3	Station 9 — $\bar{x}$	Station 10 — 1	Station 10 — 2	Station 10 — 3	Station 10 — $\bar{x}$	Station 11 — 1	Station 11 — 2	Station 11 — 3	Station 11 — $\bar{x}$	Station 12 — 1	Station 12 — 2	Station 12 — 3	Station 12 — $\bar{x}$
		Replicate and Mean Density and Biomass*															
Mollusca Gastropoda Prosobranchia	Barleeia sp.									1.0 (.004)	3.0 (.006)		1.33 (.0033)	1.0 (.003)			0.33 (.0010)
	Mitrella gouldi		1.0 (.090)		0.33 (.0300)		1.0 (.005)	1.0 (.094)	0.67 (.0330)								
Opisthobranchia	Haminoea vesicula					2.0 (.004)	1.0 (.001)		1.00 (.0017)			1.0 (.001)	0.33 (.0003)				
	Pteropod											1.0 (.028)	0.33 (.0093)				
Pelecypoda (Bivalvia)	Axinopsida serricata	3.0 (.025)	11.0 (.043)	3.0 (.014)	5.67 (.0273)	1.0 (.001)	1.0 (.001)		0.67 (.0007)					12.0 (.118)	11.0 (.057)	34.0 (.282)	19.0 (.1523)
	Compsomyax subdiaphana			1.0 (.012)	0.33 (.0040)												
	Lyonsia pugettensis		1.0 (.001)		0.33 (.0003)												
	Macoma alaskanis			2.0 (.447)	0.67 (.1490)		1.0 (.413)		0.33 (.1377)		1.0 (.065)		0.33 (.0217)		2.0 (.249)	1.0 (.056)	1.0 (.1017)
	Macoma carlottensis	5.0 (.014)	5.0 (.137)	7.0 (.007)	5.67 (.0527)	7.0 (.012)	6.0 (.126)	6.0 (.076)	6.33 (.0713)	8.0 (.037)	9.0 (.029)	6.0 (.006)	7.67 (.0240)	12.0 (.125)	14.0 (.067)	19.0 (.121)	15.0 (.1043)
	Nemocardium centifilosum							1.0 (.152)	0.33 (.0507)								
	Nuculana minuta			1.0 (.004)	0.33 (.0013)												
	Nucula tenuis		1.0 (.009)		0.33 (.0030)	2.0 (.013)		1.0 (.025)	1.0 (.0127)			2.0 (.020)	0.67 (.0067)	2.0 (.022)	1.0 (.005)	1.0 (.004)	1.33 (.0103)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

		Station 9				Station 10				Station 11				Station 12			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ERRANTIA	Density	6.0	1.0	7.0	4.65	7.0	6.0	6.0	6.32	17.0	9.0	7.0	10.99	21.0	11.0	19.0	17.00
	Biomass	.036	.010	.251	.0990	.530	.025	.365	.3066	.202	.040	.025	.0889	.979	.235	.258	.4907
	Number of species	4.0	1.0	5.0	3.33	5.0	4.0	5.0	4.67	4.0	4.0	2.0	3.33	5.0	5.0	7.0	5.67
SEDENTARIA	Density	17.0	9.0	30.0	18.66	23.0	43.0	23.0	29.64	68.0	46.0	28.0	47.31	46.0	25.0	52.0	41.00
	Biomass	.211	.041	.429	.2269	.139	.339	.624	.3672	.540	.802	.235	.5256	.588	.366	.552	.5020
	Number of species	7.0	4.0	12.0	7.67	8.0	10.0	6.0	8.00	5.0	8.0	5.0	6.00	10.0	6.0	13.0	9.67
GASTROPODA	Density		1.0		0.33	2.0	2.0	1.0	1.67	1.0	3.0	1.0	1.66	1.0			0.33
	Biomass		.090		.0300	.004	.006	.094	.0347	.004	.006	.029	.0129	.003			.0010
	Number of species		1.0		0.33	1.0	2.0	1.0	1.33	1.0	1.0	1.0	1.00	1.0			0.33
PELECYPODA	Density	8.0	18.0	14.0	13.33	10.0	8.0	8.0	8.66	8.0	10.0	9.0	9.00	26.0	28.0	55.0	36.33
	Biomass	.039	.190	.484	.2376	.026	.540	.253	.273	.037	.094	.054	.0617	.265	.378	.463	.3686
	Number of species	2.0	4.0	5.0	3.67	3.0	3.0	3.0	3.00	1.0	2.0	3.0	2.00	3.0	4.0	4.0	3.67
TOTAL	Density	31.0	29.0	51.0	36.97	42.0	59.0	38.0	46.29	94.0	68.0	45.0	68.96	94.0	64.0	126.0	94.66
	Biomass	.286	.331	1.164	.5935	.699	.910	1.336	.9816	.783	.942	.343	.6891	1.835	.979	1.273	1.3623
	Number of species	13.0	10.0	22.0	15.00	17.0	19.0	15.0	17.00	11.0	15.0	11.0	12.33	19.0	15.0	24.0	19.34

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum Class Subclass Order Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida Polychaeta Errantia																	
Arabellidae	Notocirrus californiensis						1.0 (.005)		0.33 (.0017)								
Glyceridae	Glycera capitata	2.0 (.018)	5.0 (.090)	4.0 (.055)	3.67 (.0543)	6.0 (.025)	3.0 (.016)	1.0 (.006)	3.33 (.0157)	2.0 (.008)	2.0 (.075)	3.0 (.212)	2.33 (.0983)	3.0 (.035)	4.0 (.136)		2.33 (.0570)
Goniadidae	Glycinde picta	2.0 (.013)			0.67 (.0043)			1.0 (.005)	0.33 (.0017)		2.0 (.138)	1.0 (.010)	1.0 (.0493)		1.0 (.002)	1.0 (.003)	0.67 (.0017)
Lumbrineridae	Lumbrineris luti	4.0 (.012)	2.0 (.020)	2.0 (.013)	2.67 (.0150)		1.0 (.002)	1.0 (.003)	0.67 (.0017)	1.0 (.003)	1.0 (.006)		0.67 (.0030)	4.0 (.015)	3.0 (.008)		2.33 (.0077)
	Ninoe gemma														1.0 (.013)		0.33 (.0043)
Nephtyidae	Nephtys ferruginea	7.0 (.022)	4.0 (.032)	6.0 (.016)	5.67 (.0233)	4.0 (.012)	2.0 (.004)	1.0 (.002)	2.33 (.0060)	3.0 (.015)	1.0 (.602)	5.0 (.018)	3.0 (.2117)	14.0 (.085)	11.0 (.112)		8.33 (.0657)
Onuphidae	Onuphis iridescens							1.0 (.210)	0.33 (.0700)							1.0 (.053)	0.33 (.0177)
Phyllodocidae	Eteone longa					2.0 (.007)	1.0 (.006)		1.0 (.0043)	1.0 (.003)		1.0 (.002)	0.67 (.0017)	1.0 (.016)	2.0 (.006)	1.0 (.002)	1.33 (.0080)
	Phyllodoce groenlandica			1.0 (.124)	0.33 (.0413)											1.0 (.003)	0.33 (.0010)
	Phyllodoce williamsi	1.0 (.009)			0.33 (.0030)	1.0 (.010)		1.0 (.032)	0.67 (.0140)	1.0 (.030)	2.0 (.010)	2.0 (.023)	1.67 (.0210)	1.0 (.016)			0.33 (.0053)
Polynoidae	Unknown sp.							1.0 (.006)	0.33 (.0020)						1.0 (.003)		0.33 (.0010)
Sphaerodoridae	Sphaerodoropsis sp.			2.0 (.002)	0.67 (.0007)									1.0 (.001)	1.0 (.001)		0.67 (.0007)
Syllidae	Unknown sp.	2.0 (.014)	1.0 (.010)		1.0 (.0080)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		Replicate and Mean Density and Biomass*															
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Amphicteis scaphobranchiata		5.0 (.012)		1.67 (.0040)	2.0 (.005)	1.0 (.002)		1.0 (.0023)			1.0 (.001)	0.33 (.0003)	9.0 (.015)	6.0 (.009)	1.0 (.004)	5.33 (.0093)
Capitellidae	Heteromastus cf. filobranchus	10.0 (.232)	3.0 (.041)	5.0 (.092)	6.0 (.1217)	4.0 (.052)	4.0 (.108)	2.0 (.153)	3.33 (.0743)	5.0 (.174)	10.0 (.208)	3.0 (.055)	6.0 (.1457)	6.0 (.300)	3.0 (.018)	3.0 (.205)	4.0 (.1743)
Cirratulidae	Chaetozone setosa										2.0 (.005)		0.67 (.0017)	1.0 (.003)			0.33 (.0010)
Cossuridae	Unknown sp.		1.0 (.001)		0.33 (.0003)		1.0 (.001)		0.33 (.0003)		2.0 (.003)		0.67 (.0010)				
Disomidae	Trochochaeta multisetosa		1.0 (.003)		0.33 (.0010)		2.0 (.007)	1.0 (.004)	1.00 (.0037)			1.0 (.007)	0.33 (.0023)			1.0 (.004)	0.33 (.0013)
Flabelligeridae	Unknown sp.													1.0 (.048)			0.33 (.0160)
Maldanidae	Euclymene zonalis	13.0 (.125)	7.0 (.059)	7.0 (.052)	9.0 (.0787)	2.0 (.007)	1.0 (.003)	1.0 (.004)	1.33 (.0047)					29.0 (.475)	5.0 (.025)	4.0 (.082)	12.67 (.1940)
	Praxillella gracilis	1.0 (.279)			0.33 (.0930)	1.0 (.018)			0.33 (.0060)						1.0 (.329)	1.0 (.105)	0.67 (.1447)
Opheliidae	Ammotrypane aulogaster	1.0 (.007)	1.0 (.001)		0.67 (.0027)	1.0 (.015)	1.0 (.035)	3.0 (.032)	1.67 (.0273)	1.0 (.018)	2.0 (.055)		1.00 (.0243)		1.0 (.001)		0.33 (.0003)
Orbiniidae	Haploscoloplos elongata													3.0 (.005)			1.00 (.0017)
Oweniidae	Myriochele heeri															1.0 (.001)	0.33 (.0003)
	Owenia fusiformis			2.0 (.005)	0.67 (.0017)							1.0 (.005)	0.33 (.0017)	1.0 (.002)		1.0 (.002)	0.67 (.0013)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Paraonidae	Aricidea longicornuta									1.0 (.002)			0.33 (.0007)	4.0 (.006)	1.0 (.002)	1.0 (.001)	2.00 (.0030)
	Paraonella spinifera	2.0 (.004)			0.67 (.0013)		2.0 (.003)		0.67 (.0010)					1.0 (.001)			0.33 (.0003)
Pectinariidae	Pectinaria granulata									1.0 (.038)			0.33 (.0127)				
	Pectinaria californiensis		2.0 (.165)		0.67 (.0550)												
Spionidae	Prionospio cirrifera													27.0 (.016)	2.0 (.003)	2.0 (.002)	10.33 (.0070)
	Polydora uncata	2.0 (.025)		1.0 (.002)	1.00 (.0090)	39.0 (.329)	2.0 (.017)	5.0 (.018)	15.33 (.1213)	10.0 (.065)	19.0 (.230)	6.0 (.040)	11.67 (.1117)	2.0 (.006)		1.0 (.005)	1.00 (.0037)
	Laonice cirrata	2.0 (.015)	1.0 (.127)	2.0 (1.214)	1.67 (.4520)		1.0 (.022)		0.33 (.0073)		1.0 (.334)		0.33 (.1113)	2.0 (.592)	2.0 (.253)	1.0 (.008)	1.67 (.2843)
	Prionospio malmgreni	3.0 (.008)	4.0 (.015)		2.33 (.0077)	3.0 (.010)	2.0 (.008)		1.67 (.0060)	1.0 (.002)	4.0 (.015)	2.0 (.010)	2.33 (.0090)	4.0 (.017)	2.0 (.006)	1.0 (.001)	2.33 (.0080)
Terebellidae	Artacama conifera					3.0 (.256)			1.00 (.0853)								
Trichobranchidae																	
	Pista cristata													1.0 (.010)			0.33 (.0033)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13: 1	2	3	x̄	Station 14: 1	2	3	x̄	Station 15: 1	2	3	x̄	Station 16: 1	2	3	x̄
		Replicate and Mean Density and Biomass*															
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.							1.0 (.004)	0.33 (.0013)	1.0 (.004)	1.0 (.002)		0.67 (.0020)	1.0 (.008)			0.33 (.0027)
	Mitrella gouldi		1.0 (.083)		0.33 (.0277)							1.0 (.123)	0.33 (.0410)		2.0 (.100)		0.67 (.0333)
	Polinices lewesii					1.0 (.292)			0.33 (.0973)								
Oposthobranchia	Haminoea vesicula		1.0 (.002)		0.33 (.0007)												
Pelecypoda (Bivalvia)	Axinopsida serricata	119.0 (.595)	85.0 (.461)	137.0 (.738)	113.67 (.5980)	5.0 (.007)	2.0 (.015)	1.0 (.004)	2.67 (.0087)	9.0 (.073)	11.0 (.067)	6.0 (.051)	8.67 (.0637)	257.0 (1.905)	265.0 (1.550)	8.0 (.111)	176.67 (1.1887)
	Compsomyax subdiaphana														2.0 (.668)		0.67 (.2227)
	Lucinoma annulata	1.0 (.007)			0.33 (.0023)												
	Lucinoma tenuisculpta	2.0 (1.257)		1.0 (.098)	1.00 (.4517)												
	Macoma alaskansis	3.0 (.180)	7.0 (.514(	6.0 (.215)	5.33 (.3030)	1.0 (.036)			0.33 (.0120)	1.0 (.062)		4.0 (1.282)	1.67 (.4480)	1.0 (.003)	2.0 (.017)	1.0 (.273)	1.33 (.0977)
	Macoma carlottensis	29.0 (.177)	22.0 (.077)	32.0 (.192)	27.67 (.1487)	7.0 (.099)	5.0 (.018)	9.0 (.034)	7.00 (.0503)	11.0 (.162)	4.0 (.005)	20.0 (.091)	11.67 (.0860)	13.0 (.088)	50.0 (.385)	11.0 (.115)	24.67 (.1960)
	Nemocardium centifilosum															1.0 (.022)	0.33 (.0073)
	Nuculana minuta	15.0 (.138)	8.0 (.277)	2.0 (.077)	8.33 (.1640)		1.0 (.002)	1.0 (.003)	0.67 (.0017)					1.0 (.028)	8.0 (.125)		3.0 (.0510)
	Nucula tenuis	1.0 (.011)	2.0 (.007)	3.0 (.028)	2.0 (.0153)		2.0 (.048)	1.0 (.003)	1.0 (.0170)					6.0 (.104)	14.0 (.269)	1.0 (.049)	7.0 (.1407)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Pelecypoda (Bivalvia)	Pandora filosa	1.0 (.019)			0.33 (.0063)										1.0 (.070)		0.33 (.0233)
	Yoldia thraciformis													1.0 (.016)			0.33 (.0053)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

		Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	18.0	12.0	15.0	15.01	13.0	8.0	7.0	9.32	8.0	8.0	12.0	9.34	24.0	24.0	4.0	17.31
	Biomass	.088	.152	.210	.1499	.054	.033	.264	.1171	.059	.8310	.265	.3850	.168	.281	.061	.1701
	Number of species	6.0	4.0	5.0	5.00	4.0	5.0	7.0	5.33	5.0	5.0	5.0	5.00	6.0	8.0	4.0	6.00
SEDENTARIA	Density	34.0	25.0	17.0	25.34	55.0	17.0	12.0	27.99	19.0	40.0	14.0	24.32	91.0	23.0	18.0	43.98
	Biomass	.695	.424	1.365	.8281	.692	.116	.211	.3395	.299	.850	.118	.4224	1.496	.646	.420	.8538
	Number of species	8.0	9.0	5.0	7.33	8.0	10.0	5.0	7.67	6.0	7.0	6.0	6.33	14.0	9.0	12.0	11.67
GASTROPODA	Density		2.0		0.66	1.0		1.0	0.66	1.0	1.0	1.0	1.00	1.0	2.0		1.00
	Biomass		.085		.0284	.292		.004	.0986	.004	.002	.123	.0430	.008	.100		.0360
	Number of species		2.0		0.67	1.0		1.0	0.67	1.0	1.0	1.0	1.00	1.0	1.0		0.67
PELECYPODA	Density	171.0	124.0	181.0	158.66	13.0	10.0	12.0	11.67	21.0	15.0	30.0	22.01	279.0	342.0	22.0	214.33
	Biomass	2.384	1.336	1.348	1.6893	.142	.083	.044	.0897	.297	.072	1.424	.5977	2.144	3.084	.570	1.9327
	Number of species	8.0	5.0	6.0	6.33	3.0	4.0	4.0	3.67	3.0	2.0	3.0	2.67	6.0	7.0	5.0	6.00
TOTAL	Density	223.0	163.0	213.0	199.67	82.0	35.0	32.0	49.64	49.0	64.0	57.0	56.67	395.0	391.0	44.0	276.62
	Biomass	3.167	1.997	2.923	2.6957	1.180	.232	.523	.6449	.659	1.755	1.930	1.4481	3.816	4.111	1.051	2.9926
	Number of species	22.0	20.0	16.0	19.33	16.0	19.0	17.0	17.34	15.0	15.0	15.0	15.00	27.0	25.0	21.0	24.34

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	2	3	x̄	Station 18: 1	2	3	x̄	Station 19: 1	2	3	x̄	Station 20: 1	2	3	x̄
		Replicate and Mean Density and Biomass*															
Anneldia																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera americana	1.0 (.022)		1.0 (.005)	0.67 (.0090)												
	Glycera capitata		4.0 (.046)		1.33 (.0153)	3.0 (.092)	1.0 (.010)	1.0 (.005)	1.67 (.0357)	3.0 (.110)	2.0 (.135)	2.0 (.018)	2.33 (.0877)	2.0 (.178)	2.0 (.072)	3.0 (.053)	2.33 (.1010)
Goniadidae	Glycinde armigera		1.0 (.065)	1.0 (.015)	0.67 (.0267)	2.0 (.100)		1.0 (.020)	1.0 (.0400)	1.0 (.032)			0.33 (.0107)		1.0 (.100)		0.33 (.0333)
	Glycinde picta	1.0 (.025)		1.0 (.010)	0.67 (.0117)							1.0 (.007)	0.33 (.0023)				
	Goniada brunnea	1.0 (.318)			0.33 (.1060)	1.0 (.004)			0.33 (.0013)								
Lumbrineridae	Lumbrineris bicirrata	1.0 (.035)			0.33 (.0117)												
	Lumbrineris luti	1.0 (.007)	1.0 (.011)	2.0 (.011)	1.33 (.0097)	2.0 (.009)	1.0 (.008)		1.0 (.0057)	3.0 (.020)	2.0 (.220)	1.0 (.004)	2.0 (.0813)	2.0 (.016)	1.0 (.003)	1.0 (.008)	1.33 (.0090)
	Ninoe gemma							1.0 (.058)	0.33 (.0193)								
	Lumbrineris sp.						1.0 (.012)		0.33 (.0040)								
Nephtyidae	Nephtys californiensis										1.0 (.011)		0.33 (.0037)				
	Nephtys ferruginea		3.0 (.012)		1.0 (.0040)	1.0 (.003)	3.0 (.041)	1.0 (.015)	1.67 (.0197)	4.0 (.059)		2.0 (.008)	2.0 (.0223)	1.0 (.007)	2.0 (.012)		1.0 (.0063)
Onuphidae	Diapatra ornatus		1.0 (.045)		0.33 (.0150)												
	Onuphis iridescens			1.0 (.073)	0.33 (.0243)	1.0 (.112)	4.0 (.059)	1.0 (.006)	2.0 (.0590)		3.0 (.151)	5.0 (.105)	2.67 (.0853)	1.0 (.031)			0.33 (.0103)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Errantia																	
Phyllodocidae	Eteone longa					1.0 (.031)			0.33 (.0103)	1.0 (.003)			0.33 (.0010)				
	Phyllodoce williamsi	1.0 (.012)	1.0 (.004)		0.67 (.0053)	2.0 (.025)	3.0 (.025)		1.67 (.0167)		1.0 (.042)		0.33 (.0140)	1.0 (.006)		1.0 (.006)	0.67 (.0040)
Polynoidae	Unknown sp.		2.0 (.009)		0.67 (.0030)											1.0 (.005)	0.33 (.0017)
Syllidae	Unknown sp.		3.0 (.010)		1.0 (.0033)		3.0 (.004)		1.0 (.0013)					3.0 (.023)			1.0 (.0077)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17				Station 18				Station 19				Station 20			
		Replicate and Mean Density and Biomass*															
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Anneldia																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Melinna cristata					1.0 (.003)			0.33 (.0010)								
Capitellidae	cf. Heteromastus filobranchus	1.0 (.042)	7.0 (.252)	7.0 (.219)	5.00 (.1710)	7.0 (.227)	3.0 (.138)	1.0 (.007)	3.67 (.1240)	6.0 (.112)	3.0 (.048)	10.0 (.220)	6.33 (.1267)	5.0 (.083)	3.0 (.025)	5.0 (.026)	4.33 (.0447)
Disomidae	Trochaeta multisetosa									1.0 (.006)	1.0 (.006)		0.67 (.0040)		1.0 (.005)		0.33 (.0017)
Flabelligeridae	Unknown sp.		1.0 (.010)		0.33 (.0033)		1.0 (.001)		0.33 (.0003)								
Magelonidae	Magelona sp.					1.0 (.001)			0.33 (.0003)								
Maldanidae	Asychis similis					1.0 (.012)			0.33 (.0040)								
	Euclymene zonalis	2.0 (.012)	6.0 (.012)	1.0 (.004)	3.00 (.0093)	12.0 (.032)	7.0 (.023)	1.0 (.013)	6.67 (.0227)	6.0 (.074)	5.0 (.063)	3.0 (.046)	4.67 (.0610)	8.0 (.147)		3.0 (.029)	3.67 (.0587)
	Praxillella gracilis			1.0 (.148)	0.33 (.0493)	1.0 (.056)	1.0 (.060)		0.67 (.0387)	2.0 (.023)	3.0 (.838)		1.67 (.2870)	2.0 (.146)	3.0 (.178)	1.0 (.105)	2.00 (.1430)
Opheliidae	Ammotrypane aulogaster									1.0 (.025)			0.33 (.0083)				
Orbiniidae	Haploscoloplos elongata		1.0 (.004)		0.33 (.0013)	1.0 (.002)	2.0 (.007)		1.00 (.0030)								
Oweniidae	Owenia fusiformis						1.0 (.002)		0.33 (.0007)	1.0 (.005)			0.33 (.0017)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	Station 17: 2	Station 17: 3	Station 17: x̄	Station 18: 1	Station 18: 2	Station 18: 3	Station 18: x̄	Station 19: 1	Station 19: 2	Station 19: 3	Station 19: x̄	Station 20: 1	Station 20: 2	Station 20: 3	Station 20: x̄
Sedentaria																	
Paraonidae	Aricidea longicornuta			1.0 (.003)	0.33 (.0010)	1.0 (.002)	1.0 (.001)		0.67 (.0010)	1.0 (.002)		1.0 (.002)	0.67 (.0013)				
	Paraonella spinifera					1.0 (.001)			0.33 (.0003)	1.0 (.001)			0.33 (.0003)		1.0 (.002)		0.33 (.0007)
Sabellidae	Unknown sp.		1.0 (.006)		0.33 (.0020)												
Spionidae	Polydora sp.									1.0 (.003)		1.0 (.004)	0.67 (.0023)				
	Laonice cirrata			1.0 (.170)	0.33 (.0567)		1.0 (.665)		0.33 (.2220)		3.0 (1.132)	1.0 (.023)	1.33 (.3850)	1.0 (.462)	1.0 (1.569)	1.0 (.023)	1.00 (.6847)
	Prionospio malmgreni											1.0 (.018)	0.33 (.0060)				
	Spionophanes sp.											1.0 (.010)	0.33 (.0033)				
Terebellidae	Artacama conifera		1.0 (.022)		0.33 (.0073)		1.0 (.025)		0.33 (.0083)	1.0 (.008)			0.33 (.0027)	1.0 (.005)			0.33 (.0017)
Trichobranchidae	Terebellidae stroemi						1.0 (.002)		0.33 (.0007)	1.0 (.012)			0.33 (.0040)		3.0 (.010)	1.0 (.007)	1.33 (.0057)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Pelecypoda (Bivalvia)	Macoma carlottensis	4.0 (.057)	6.0 (.049)	8.0 (.067)	6.00 (.0577)	9.0 (.075)		1.0 (.022)	3.33 (.0323)	15.0 (.095)	4.0 (.070)		6.33 (.0550)	7.0 (.051)	9.0 (.105)	6.0 (.076)	7.33 (.0773)
	Nemocardium centifilosum	1.0 (.045)	4.0 (.629)	4.0 (.086)	3.0 (.2533)		6.0 (.243)		2.0 (.0810)					1.0 (.061)			0.33 (.0203)
	Nuculana minuta	2.0 (.036)	3.0 (.588)	7.0 (.219)	4.0 (.2810)	7.0 (.255)	7.0 (.126)	7.0 (.358)	7.0 (.2463)	1.0 (.020)		1.0 (.016)	0.67 (.0120)	2.0 (.023)	1.0 (.035)	1.0 (.042)	1.33 (.0333)
	Nucula tenuis	3.0 (.039)	5.0 (.079)	3.0 (.083)	3.67 (.0670)	3.0 (.008)	8.0 (.042)	6.0 (.166)	5.67 (.0720)	4.0 (.084)			1.33 (.0280)	1.0 (.025)		1.0 (.024)	0.67 (.0163)
	Yoldia sissurata									1.0 (.021)			0.33 (.0070)		1.0 (.300)		0.33 (.1000)

26

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.	1.0 (.014)		4.0 (.005)	1.67 (.0063)												
	Bittium subplanatum						2.0 (.003)		0.67 (.0010)								
	Calliostoma sp.															1.0 (.006)	0.33 (.0020)
	Mitrella gouldi	1.0 (.102)			0.33 (.0340)										1.0 (.034)		0.33 (.0113)
	Oenopota elegans														1.0 (.042)		0.33 (.0140)
Opisthobranchia	Turbonilla sp.														1.0 (.022)		0.33 (.0073)
Pelecypoda (Bivalvia)	Ascila castrensis									2.0 (.088)			0.67 (.0293)				
	Axinopsida serricata	76.0 (.205)	64.0 (.417)	89.0 (.219)	76.33 (.2803)	127.0 (.281)	91.0 (.283)	127.0 (.338)	115.0 (.3007)	190.0 (.450)	33.0 (.112)	150.0 (.569)	124.33 (.3770)	146.0 (.534)	90.0 (.363)	98.0 (.453)	111.33 (.4500)
	Cardiomya oldroydi		1.0 (.019)	1.0 (.003)	0.67 (.0073)		1.0 (.003)		0.33 (.0010)	1.0 (.019)			0.33 (.0063)				
	Compsomyax subdiaphana		1.0 (.257)	1.0 (.069)	0.67 (.1087)	1.0 (.065)	2.0 (.569)		1.0 (.2113)							1.0 (.101)	0.33 (.0337)
	Lucinoma annulata							1.0 (.138)	0.33 (.0460)		1.0 (.351)		0.33 (.1170)				
	Lucinoma tenuisculpta													1.0 (.367)	1.0 (.748)		0.67 (.3717)
	Macoma alaskansis	5.0 (.137)	6.0 (.250)	4.0 (.064)	5.0 (.1503)	8.0 (.266)	5.0 (.210)	4.0 (.132)	5.67 (.2027)			6.0 (.062)	2.0 (.0207)	1.0 (.012)		1.0 (.014)	0.67 (.0087)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

		Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	6.0	16.0	6.0	9.33	13.0	16.0	5.0	11.33	12.9	9.0	11.0	10.65	10.0	6.0	6.0	7.32
	Biomass	.419	.202	.114	.2450	.376	.159	.104	.2130	.224	.559	.142	.3083	.261	.187	.072	.1733
	Number of species	6.0	8.0	5.0	6.33	8.0	7.0	5.0	6.67	5.0	5.0	5.0	5.00	6.0	4.0	4.0	4.67
SEDENTARIA	Density	3.0	17.0	11.0	10.31	26.0	19.0	2.0	15.65	22.0	15.0	18.0	18.32	17.0	12.0	11.0	13.32
	Biomass	.054	.306	.544	.3012	.336	.9242	.020	.4270	.271	2.087	.323	.8936	.843	1.789	.190	.9409
	Number of species	2.0	6.0	5.0	4.33	9.0	10.0	2.0	7.0	11.0	5.0	7.0	7.67	5.0	6.0	5.0	5.33
GASTROPODA	Density	2.0		4.0	2.00		2.0		0.67						3.0	1.0	1.33
	Biomass	.116		.005	.0403		.003		.0010						.098	.006	.0347
	Number of species	2.0		1.0	1.00		1.0		0.33						3.0	1.0	1.33
PELECYPODA	Density	91.0	90.0	117.0	99.34	155.0	120.0	146.0	140.33	214.0	38.0	157.0	136.32	159.0	102.0	108.0	122.99
	Biomass	.519	2.288	.810	1.2057	.950	1.476	1.154	1.1933	.777	.533	.647	.6523	1.073	1.551	.710	1.1113
	Number of species	6.0	8.0	8.0	7.33	6.0	7.0	6.0	6.33	7.0	3.0	3.0	4.33	7.0	5.0	6.0	6.00
TOTAL	Density	102.0	123.0	138.0	120.98	194.0	157.0	153.0	167.98	248.0	62.0	186.0	165.29	186.0	123.0	126.0	144.96
	Biomass	1.108	2.796	1.473	1.7922	1.662	2.5622	1.278	1.8343	1.272	3.179	1.112	1.8542	2.177	3.625	.978	2.2602
	Number of species	16.0	22.0	19.0	18.99	23.0	25.0	13.0	20.33	23.0	13.0	15.0	17.00	18.0	15.0	16.0	17.33

28

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

		Replicate and Mean Density and Biomass*															
		Station 1,5,9,13,17				Station 2,6,10,14,18				Station 3,7,11,15,19				Station 4,8,12,16,20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density																
	Biomass																
	Number of species																
SEDENTARIA	Density																
	Biomass																
	Number of species																
GASTROPODA	Density																
	Biomass																
	Number of species																
PELECYPODA	Density																
	Biomass																
	Number of species																
TOTAL	Density	608.0	546.0	638.0	597.20	437.0	344.0	323.0	367.90	447.0	378.0	526.0	450.23	1080.0	734.0	452.0	755.21
	Biomass	7.735	9.605	9.823	9.0541	5.161	4.9782	4.065	4.7348	3.319	8.149	5.680	5.7156	13.107	11.898	5.303	10.0960
	Number of species	91.0	86.0	89.0	88.66	90.0	93.0	75.0	86.01	66.0	82.0	70.0	72.66	107.0	102.0	100.0	103.01

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: x̄	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: x̄	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: x̄	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: x̄
		Replicate and Mean Density and Biomass*															
Nemertea																	
Cerebratula	Juvenile sp.					1.0 (.010)			0.33 (.0033)			1.0 (.008)	0.33 (.0027)	1.0 (.116)	1.0 (.005)	1.0 (.135)	1.00 (.0853)
	Adult sp.											1.0 (.248)	0.33 (.0837)				
Arthropoda																	
Crustacea	Ostrocods									1.0 (.001)			0.33 (.0003)				
Cumacea	Unknown sp.										2.0 (.007)		0.67 (.0023)	2.0 (.004)			0.67 (.0013)
Amphipoda	Unknown sp.	3.0 (.006)	1.0 (.003)	5.0 (.028)	3.00 (.0123)					1.0 (.001)	1.0 (.003)	5.0 (.010)	2.33 (.0047)	1.0 (.007)			0.33 (.0023)
Tanadacea	Unknown sp.											1.0 (.001)	0.33 (.0003)		1.0 (.002)		0.33 (.0007)
Isopoda	Unknown sp.		1.0 (.002)		0.33 (.001)												
Porifera	Unknown sp.											1.0 (.082)	0.33 (.0273)				
Echinodermata																	
Ophiuroidae	Unknown sp.													1.0 (.002)			0.33 (.0007)

****

		Station 1: 1	Station 1: 2	Station 1: 3	Station 1: x̄	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: x̄	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: x̄	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: x̄
	Density	3.0	2.0	5.0	3.33	1.0			0.33	2.0	3.0	9.0	4.65	5.0	2.0	1.0	2.66
	Biomass	.006	.005	.028	.0133	.010			.0033	.002	.010	.349	.1203	.129	.007	.135	.0903
Number of	Species	1.0	2.0	1.0	1.33	1.0			0.33	2.0	2.0	5.0	3.00	4.0	2.0	1.0	2.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Nemertea																	
Cerebratula	Adult sp.														1.0 (.016)		0.33 (.0053)
Arthropoda																	
Crustacea																	
Cumacea	Unknown sp.	1.0 (.002)			0.33 (.0007)												
Amphipoda	Unknown sp.							1.0 (.002)	0.33 (.0007)		2.0 (.004)		0.67 (.0013)				
Tanadacea	Unknown sp.										1.0 (.002)		0.33 (.0007)				
Echinodermata																	
Ophiuroidae	Unknown sp.	1.0 (.003)			0.33 (.0010)						1.0 (.003)		0.33 (.0010)				
							************										
	Density	2.0			0.66			1.0	0.33		4.0		1.33		1.0		0.33
	Biomass	.005			.0017			.002	.0007		.009		.0030		.016		.0053
	Number of Species	2.0			0.67			1.0	0.33		3.0		1.00		1.0		0.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 9: 1	Station 9: 2	Station 9: 3	Station 9: $\bar{x}$	Station 10: 1	Station 10: 2	Station 10: 3	Station 10: $\bar{x}$	Station 11: 1	Station 11: 2	Station 11: 3	Station 11: $\bar{x}$	Station 12: 1	Station 12: 2	Station 12: 3	Station 12: $\bar{x}$
Nemertea																	
Cerebratulus	Adult sp.													1.0 (.621)	1.0 (.018)		0.67 (.213)
	Juvenile sp.			2.0 (.042)	0.67 (.0140)										1.0 (.012)		0.33 (.0040)
Arthropoda																	
Crustacea																	
Ostrocoda	Unknown sp.						1.0 (.001)		0.33 (.0003)	1.0 (.001)			0.33 (.0003)				
Cumacea			1.0 (.006)		0.33 (.0020)												
Amphipoda	Unknown sp.			1.0 (.001)	0.33 (.0003)			2.0 (.012)	0.67 (.0040)		1.0 (.002)	1.0 (.002)	0.67 (.0013)	1.0 (.001)			0.33 (.0007)
Echinodermata																	
Ophiuroidae	Unknown sp.											1.0 (.002)	0.33 (.0007)				
	*************																
	Density		1.0	3.0	1.33		1.0	2.0	1.00	1.0	1.0	2.0	1.33	2.0	2.0		1.33
	Biomass		.006	.043	.0163		.001	.012	.0043	.001	.002	.004	.0023	.622	.030		.2177
Number of Species			1.0	2.0	1.00		1.0	1.0	0.67	1.0	1.0	2.0	1.33	2.0	2.0		1.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum Class Subclass Order Family	Scientific Name	Station 13 1	2	3	x̄	Station 14 1	2	3	x̄	Station 15 1	2	3	x̄	Station 16 1	2	3	x̄
		Replicate and Mean Density and Biomass*															
Sipuncula	Unknown sp.			1.0 (.008)	0.33 (.0027)												
Nemertea Cerebratulus	Adult sp.	1.0 (.010)	1.0 (.018)	1.0 (.061)	1.00 (.0297)							1.0 (.038)	0.33 (.0127)	1.0 (.332)			0.33 (.1107)
	Juvenile sp.						1.0 (.005)		0.33 (.0017)					1.0 (.015)	1.0 (.107)		0.67 (.0407)
Arthropoda Crustacea Malacostraca	Unknown sp. (Shrimp)													1.0 (.016)			0.33 (.0053)
	Unknown sp. (crabs)		2.0 (.018)		0.67 (.0060)			1.0 (.010)	0.33 (.0033)	1.0 (.005)	1.0 (.004)		0.67 (.003)			1.0 (.003)	0.33 (.0010)
Cumacea	Unknown sp.	1.0 (.003)	1.0 (.004)		0.67 (.0023)	1.0 (.003)	1.0 (.008)		0.67 (.0037)	1.0 (.001)			0.33 (.0003)				
Amphipoda	Unknown sp.	3.0 (.012)	1.0 (.003)	2.0 (.004)	2.00 (.0063)					1.0 (.004)		2.0 (.004)	1.00 (.0027)	4.0 (.006)	1.0 (.003)		1.67 (.0030)
Echinodermata Ophiuroidea	Unknown sp.						1.0 (.005)	1.0 (.003)	0.67 (.0027)	1.0 (.002)			0.33 (.0007)				
Holothuroidea	Unknown sp.		1.0 (.006)		0.33 (.0020)										1.0 (12.030)		0.33 (4.0100)
	*************																
	Density	5.0	6.0	4.0	5.00	1.0	3.0	2.0	2.00	4.0	1.0	3.0	2.66	7.0	3.0	1.0	3.66
	Biomass	.025	.049	.073	.0490	.003	.018	.013	.0114	.012	.004	.042	.0194	.369	12.140	.003	4.1707
Number of	Species	3.0	5.0	3.0	3.67	1.0	3.0	2.0	2.00	4.0	1.0	2.0	2.33	4.0	3.0	1.0	2.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 8 December 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Sipuncula	Unknown sp.		1.0 (.005)		0.33 (.0017)	3.0 (.072)			1.00 (.0240)								
Nemertea Cerebratulus	Adult sp.										1.0 (.498)		0.33 (.1660)				
	Juvenile sp.		1.0 (.015)		0.33 (.005)	1.0 (.033)	1.0 (.035)		0.67 (.0227)								
Arthropoda Crustacea Malacostraca	Unknown sp. (Shrimp)									1.0 (.025)			0.33 (.0083)				
Cumacea	Unknown sp.	1.0 (.007)			0.33 (.0023)		2.0 (.003)		0.67 (.0010)								
Amphipoda	Unknown sp.	1.0 (.003)	5.0 (.007)		2.00 (.0033)	2.0 (.004)	3.0 (.004)	1.0 (.001)	2.00 (.003)	7.0 (.028)			2.33 (.0093)	2.0 (.006)			0.67 (.0020)
Tanadacea	Unknown sp.			1.0 (.001)	0.33 (.0003)		3.0 (.003)	2.0 (.002)	1.67 (.0017)								
Echinodermata Ophiuroidea	Unknown sp.					1.0 (.002)			0.33 (.0007)								
	Density	2.0	7.0	1.0	3.32	7.0	9.0	3.0	6.34	8.0	1.0		3.00	2.0			0.67
	Biomass	.010	.027	.001	.0126	.111	.045	.003	.0531	.053	.498		.1836	.006			.002
	Number of Species	2.0	3.0	1.0	2.00	4.0	4.0	2.0	3.33	2.0	1.0		1.00	1.0			0.33
Cumulative	Density	12.0	16.0	13.0	13.64	9.0	13.0	8.0	10.00	15.0	10.0	14.0	21.97	16.0	8.0	2.0	8.65
Cumulative	Biomass	.046	.087	.145	.0926	.124		.030	.0728	.068	.523	.395	.3286	1.126	12.193	.138	4.4860
Cumulative	Number of Species	8.0	11.0	7.0	8.67	6.0	8.0	6.0	6.66	9.0	8.0	9.0	8.66	11.0	8.0	2.0	6.99

Field and Laboratory Description of Sediment Grab Sample

Sampled 8 December 1976

	Station 17				Station 18				Station 19				Station 20			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	210.0	200.0	195.0	201.67	195.0	200.0	205.0	200.00	172.0	170.0	170.0	170.67	180.0	180.0	165.0	175.00
Sample Volume - Litres	4.4	3.0	6.2	4.53	6.7	9.4	10.6	8.90	6.0	6.1	11.9	8.00	6.1	5.5	5.2	5.60
Sample Residue ml/l	90.9	29.9	145.0	88.60	111.9	138.3	63.7	104.63	100.0	229.5	67.2	132.23	196.7	145.5	173.0	171.73
Percent Rock	90.0	24.5	97.0	70.5	95.0	96.1	93.0	94.70	60.0	95.0	80.0	78.33	32.9	50.0	85.0	55.97
Volume Rock ml/l	81.8	73.3	140.8	98.63	106.3	133.1	59.2	99.53	60.0	218.0	53.8	110.60	64.8	72.7	147.0	94.33
Percent Wood & Fibers	5.0	0	0	1.67	.33	.38	0	.25	37.0	1.2	17.0	18.40	62.0	49.0	14.0	41.67
Volume Wood and Fibers ml/l	1.96			.65	1.06			.35	37.0	2.9	11.4	17.10	122.1	71.3	24.2	72.53
Percent Wood	5.0	0	0	1.67	0	.3	0	.1	2.0	1.2	12.0	5.1	32.0	9.0	4.0	15.0
Volume Wood ml/l	1.9	0	0	.65	0	.5	0	.18	2.0	2.9	8.0	4.30	63.1	13.1	6.9	27.70
Percent Fibers	0	0	0	0	0	.3	0	.10	35.0	0	5.0	13.33	30.0	40.0	10.0	26.67
Volume Fibers ml/l	0	0	0	0	0	.5	0	.18	35.0	0	3.6	12.87	59.0	58.2	17.3	44.83
Surficial Layer Thickness																
Color Sediment																
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 8 December 1976

	Station 13				Station 14				Station 15				Station 16			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	180.0	180.0	180.0	180.00	190.0	188.0	185.0	187.67	194.0	194.0	194.0	194.00	200.0	200.0	204.0	201.33
Sample Volume - Litres	11.7	11.5	8.2	10.46	5.3	8.6	11.0	8.30	9.7	6.8	8.9	8.47	11.8	12.9	10.2	11.63
Sample Residue ml/l	72.7	87.0	146.3	102.00	141.5	226.7	118.2	162.13	126.3	73.5	162.9	120.90	80.5	38.8	78.4	65.76
Percent Rock	6.1	0	5.0	3.70	0	0	0	0	2.4	0	0	.80	0	0	0	0
Volume Rock ml/l	4.5	0	7.3	3.93	0	0	0	0	3.1	0	0	1.00	0	0	0	0
Percent Wood & Fibers	90.3	97.0	91.3	92.86	94.6	68.5	97.0	86.70	97.2	98.0	97.0	97.40	96.3	80.0	97.0	91.10
Volume Wood and Fibers ml/l	65.6	84.4	133.6	94.53	133.9	155.5	114.6	134.67	122.8	72.1	158.1	117.67	67.7	31.0	76.1	58.23
Percent Wood	41.1	80.0	56.6	59.23	37.6	38.3	49.6	41.83	60.0	23.0	65.5	49.51	21.1	0	60.0	27.03
Volume Wood ml/l	29.9	69.6	82.9	60.80	53.2	86.9	58.7	66.27	75.8	16.9	106.8	66.50	17.0	0	47.1	21.37
Percent Fibers	49.1	17.0	34.6	33.57	57.0	30.2	47.3	44.83	37.2	75.0	31.4	47.86	75.2	80.0	37.0	64.07
Volume Fibers ml/l	35.7	14.8	50.7	33.73	80.7	68.6	55.9	68.10	47.0	55.2	51.3	51.17	60.6	31.0	29.0	40.20
Surficial Layer Thickness																
Color Sediment																
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 8 December 1976

	Station 9				Station 10				Station 11				Station 12			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	196.0	195.0	188.0	193.00	198.0	192.0	195.0	195.00	194.0	205.0	195.0	198.00	210.0	208.0	210.0	209.33
Sample Volume - Litres	5.5	7.5	9.3	7.43	11.9	6.9	11.2	10.00	9.8	9.3	10.5	9.86	9.4	7.9	6.8	8.00
Sample Residue ml/l	118.2	125.3	166.7	136.73	33.6	94.2	44.6	57.47	56.1	43.0	47.6	48.90	191.5	164.6	161.8	172.63
Percent Rock	5.0	28.0	4.8	12.60	2.0	5.0	5.0	4.00	10.0	20.0	47.0	25.67	1.6	5.0	4.6	3.73
Volume Rock ml/l	5.9	35.1	8.1	16.36	.6	4.7	2.2	2.50	5.6	8.6	22.4	12.20	3.2	8.2	7.5	6.30
Percent Wood & Fibers	91.0	69.8	92.1	84.31	95.0	90.0	92.0	92.33	88.2	75.0	50.0	71.07	95.3	92.0	92.3	93.20
Volume Wood and Fibers ml/l	107.5	87.6	153.5	116.20	32.0	84.7	38.1	51.60	47.7	32.3	23.8	34.70	182.6	151.4	149.4	161.13
Percent Wood	66.0	49.8	37.1	50.98	10.0	70.0	30.0	36.67	20.0	35.0	30.0	28.33	43.7	42.7	69.5	51.97
Volume Wood ml/l	78.0	62.5	61.8	67.43	3.4	65.9	13.4	27.57	11.2	15.1	14.3	13.53	83.8	70.4	112.5	88.90
Percent Fibers	25.0	20.0	55.0	33.33	85.0	20.0	62.0	55.67	68.2	40.0	20.0	42.73	51.5	49.2	22.8	41.17
Volume Fibers ml/l	29.5	25.1	91.7	48.77	28.6	18.8	27.7	25.03	36.5	17.2	9.5	21.07	98.8	81.0	36.9	72.23
Surficial Layer Thickness																
Color Sediment																
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 8 December 1976

	Station 5				Station 6				Station 7				Station 8			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	200.0	200.0	200.0	200.00	200.0	200.0	200.0	200.00	209.0	208.0	218.0	211.67	217.0	217.0	216.0	216.67
Sample Volume - Litres	9.0	6.4	5.2	6.86	5.2	8.0	6.0	6.40	9.3	4.8	6.2	6.76	10.6	11.9	5.8	9.43
Sample Residue ml/l	111.1	148.0	125.0	128.03	442.0	162.5	166.6	257.03	59.1	125.0	88.7	90.93	103.8	113.5	163.8	127.03
Percent Rock	6.0	8.3	10.0	8.11	4.1	10.0	7.0	7.05	30.0	27.0	60.0	39.00	2.9	4.3	1.0	2.76
Volume Rock ml/l	6.6	12.3	12.5	10.47	18.4	16.3	11.7	15.46	17.7	33.8	53.2	34.90	3.0	4.9	1.9	3.27
Percent Wood & Fibers	91.0	88.6	87.0	88.67	92.8	86.0	90.0	89.60	66.0	70.0	37.0	47.67	90.4	92.8	96.0	39.07
Volume Wood and Fibers ml/l	101.1	131.6	108.8	113.83	410.4	139.9	150.0	233.43	39.0	87.5	32.8	53.1	93.9	105.4	157.3	118.87
Percent Wood	57.0	29.7	20.0	35.58	37.8	25.3	64.0	42.47	22.0	20.0	30.0	24.00	20.0	43.2	15.6	26.27
Volume Wood ml/l	63.3	44.1	25.0	44.13	167.0	41.3	106.7	105.00	13.0	25.0	26.6	21.53	20.8	49.1	25.7	31.86
Percent Fibers	34.0	58.9	67.0	53.30	55.0	69.6	26.0	47.20	44.0	50.0	7.0	33.67	70.4	49.5	80.3	66.73
Volume Fibers ml/l	37.8	87.5	83.8	69.70	243.4	98.6	43.3	128.43	26.0	62.5	6.2	31.57	73.1	56.3	131.6	87.00
Surficial Layer Thickness																
Color Sediment																
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 8 December 1976

	Station 1				Station 2				Station 3				Station 4			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	200.0	200.0	200.0	200.00	200.0	198.0	198.0	198.67	217.0	215.0	218.0	216.67	220.0	225.0	225.0	223.33
Sample Volume - Litres	10.4	7.0	10.5	9.33	6.7	6.8	5.2	6.23	5.2	6.1	6.2	5.83	10.7	11.0	9.4	10.37
Sample Residue ml/l	125.0	154.0	97.1	125.37	74.6	58.8	60.6	64.67	192.0	98.4	161.3	150.57	37.4	95.5	159.6	97.50
Percent Rock	10.0	2.5	3.5	5.37	5.0	4.0	6.9	5.33	4.0	2.0	.7	2.23	5.0	0	1.2	2.07
Volume Rock ml/l	12.5	3.9	3.4	6.60	3.7	2.4	4.2	3.37	7.7	1.9	.1	3.23	1.9	0	1.9	1.27
Percent Wood & Fibers	103.0	85.5	91.1	93.20	91.0	90.0	90.0	90.33	92.0	93.0	94.3	93.10	90.0	89.0	92.8	90.60
Volume Wood and Fibers ml/l	103.9	132.0	88.6	108.17	67.9	52.9	54.5	58.43	176.7	91.4	152.1	140.07	33.6	85.0	148.1	88.90
Percent Wood	8.0	39.4	27.2	24.86	71.0	50.0	70.0.	63.67	62.0	53.0	54.5	56.52	45.0	17.1	33.8	31.98
Volume Wood ml/l	10.1	60.9	26.5	32.50	53.0	29.4	42.4	41.60	119.0	52.1	88.0	86.37	16.8	16.4	53.9	29.03
Percent Fibers	75.0	46.1	63.9	61.67	20.0	40.0	20.0	26.67	30.0	40.0	39.7	36.57	45.0	71.8	59.0	58.60
Volume Fibers ml/l	93.8	71.1	62.1	75.67	14.9	23.5	12.1	16.83	57.7	39.3	64.1	53.70	16.8	68.6	94.2	59.87
Surficial Layer Thickness																
Color Sediment																
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Density of Worm Tubes, Elliott Bay
December 8,9. 1976

		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1	1.0	2.0		1.00			2.0	0.67	1.0			0.33		2.0	1.0	1.00
	MF5		1.0	1.0	0.67							2.0	0.67	4.0			1.33
	MF6	6.0	5.0	5.0	5.33					2.0	1.0	3.0	2.00	8.0	1.0		3.00
	MF9	2.0	13.0	13.0	9.33					4.0	1.0	8.0	4.33	16.0	5.0		7.00
	MF10		1.0		0.33											4.0	1.33
	MR3		1.0		0.33									2.0	3.0		1.67
	MR12										1.0		0.33				
	MR15											2.0	0.67				
	MR11										1.0		0.33				
Sand Tubes	SF9									1.0		1.0	0.67	6.0	1.0		2.33
	SR3	1.0	1.0		0.67					4.0	3.0	5.0	4.00	4.0	8.0	2.0	4.67
	SR4										3.0		1.00				
	SR7	542.0	183.0	1106.0	610.33	8.0	1.0		3.00	6.0	80.0	87.0	57.67	200.0	200.0	138.0	179.33
	SR8	15.0	2.0		5.67						5.0	6.0	3.67				
	SR11											2.0	0.67				
	SR18					4.0		2.0	2.00						1.0		0.33
	SR20					1.0			0.33			1.0	0.33	2.0			0.67
	SR25	2.0		4.0	2.00	8.0	7.0	13.0	9.33	4.0	6.0	7.0	5.67		15.0	4.0	6.33
	SI4			5.0	1.67	26.0	54.0	70.0	50.00	3.0	8.0		3.67		6.0	1.0	2.33
	SC1			6.0		2.0			0.67	2.0		3.0	1.67	9.0	2.0		3.67
Mucous Membrane Tubes	MM13		3.0	5.0	35.00	16.67				1.0		3.0	1.33	4.0	8.0	7.0	6.33
	MM14											1.0	0.33				
	MM15											1.0	0.33				
	MM17	1.0			0.33							1.0	0.33				
	MM19	1.0			0.33												
	PC2										1.0		0.33				

Density of Worm Tubes, Elliott Bay
December 8,9, 1976

		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1	1.0			0.33												
	MF5					2.0			0.67								
	MF6	1.0		2.0	1.00	14.0		4.0	6.00		1.0		0.33	5.0	7.0	7.0	6.33
	MF9	1.0			0.33	3.0	1.0	1.0	1.67		5.0		1.67	1.0	3.0		1.33
	MF10						4.0	2.0	3.00		1.0		0.33	3.0		1.0	1.33
	MR3													1.0		2.0	1.00
	MR15															2.0	0.67
Sand Tubes	SR3		1.0		0.33	1.0		2.0	1.00	1.0			0.33	1.0		2.0	1.00
	SR7	1.0	1.0	80.0	27.33	85.0	1.0	3.0	29.67	3.0		3.0	2.00	162.0	29.0	4.0	65.00
	SR18			1.0	0.33		11.0	1.0	4.00			9.0	3.00		2.0	1.0	1.00
	SR20					4.0	6.0		3.33	4.0	1.0	4.0	3.00		2.0	1.0	1.00
	SR25	5.0	3.0	18.0	8.67	11.0	6.0	1.0	6.00		2.0		0.67	20.0	5.0	4.0	9.67
	SI4	26.0	2.0	62.0	30.00	7.0	13.0	5.0	8.33	170.0	26.0	88.0	94.67		2.0	8.0	3.33
	SC1	2.0		1.0	1.00	1.0	2.0	1.0	1.33	1.0			0.33	1.0	3.0		1.33
Mucous Membrane Tubes	MM3	1.0	1.0		0.67	5.0	18.0	5.0	9.33			1.0	0.33	2.0	9.0	8.0	6.33
	MM14											1.0	0.33				
	MM17			2.0	0.67										1.0	1.0	0.67
	MM19		1.0	2.0	1.00									2.0	2.0		1.33

Density of Worm Tubes, Elliott Bay
December 8,9, 1976

		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF6		1.0	2.0	1.00		1.0		0.33		4.0		1.33		11.0	2.0	4.33
	MF9	2.0		1.0	1.00									2.0	6.0		2.67
	MF10							1.0	0.33		1.0		0.33				
	MR3															3.0	1.00
	MR6						9.0		3.00								
	MR7							2.0	0.67								
	MR15														1.0		0.33
Sand Tubes	SF3	2.0			0.67												
	SF9							4.0	1.33								
	SR3			3.0	1.00			1.0	0.33							2.0	0.67
	SR4														9.0	3.0	4.00
	SR7					5.0	1.0		2.00					181.0	1.0	137.0	105.33
	SR8	5.0			1.67											2.0	0.67
	SR18		18.0	5.0	7.67			1.0	0.33	1.0	3.0	3.0	2.33		5.0		1.67
	SR20		14.0	3.0	5.67		5.0		1.67		1.0		0.33	4.0	3.0	6.0	4.33
	SR25	4.0		6.0	3.33			11.0	3.67					3.0	2.0	6.0	3.67
	SI4	14.0	23.0	48.0	23.33	34.0	71.0	105.0	70.00	248.0	132.0	169.0	183.00	22.0		12.0	11.33
	SC1	1.0	5.0	6.0	4.00		7.0		2.33	1.0			0.33	1.0	4.0	1.0	2.00
	SC2	1.0		1.0	0.67		1.0		0.33			1.0	0.33		1.0		0.33
Mucous Membrane Tubes	MM13	7.0		2.0	3.00						3.0		1.00	7.0	8.0	8.0	7.67
	MM17															2.0	0.67
	MM19	1.0			0.33		1.0	2.0	1.00					1.0	2.0	1.0	1.33

12

Density of Worm Tubes, Elliott Bay
December 8,9, 1976

		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1		1.0		0.33	1.0			0.33								
	MF5		1.0		0.33									1.0			0.33
	MF6	2.0	8.0		3.33		2.0	7.0	3.00			5.0	1.67	4.0	2.0	2.0	2.67
	MF9		1.0		0.33		2.0		0.67					2.0			0.67
	MR6							1.0	0.33								
Sand Tubes	SF3						4.0		1.33					3.0			1.00
	SF9	1.0	1.0		0.67										4.0		1.33
	SR3	2.0	2.0	1.0	1.67		1.0	1.0	0.67	3.0		1.0	1.33			6.0	2.00
	SR4	7.0			2.33					3.0		5.0	2.67		11.0		3.67
	SR7	193.0	51.0	150.0	67.00	7.0	16.0	9.0	32.00			2.0	0.67	596.0	366.0	55.0	339.00
	SR8					9.0			3.00						23.0	17.0	13.33
	SR14	2.0			0.67									4.0			1.67
	SR15														3.0		1.00
	SR18					2.0		1.0	1.00	4.0			1.33	3.0	1.0		1.33
	SR20						2.0	2.0	1.67	1.0		1.0	0.67	8.0	4.0		4.00
	SR25		8.0		2.67			3.0	1.00	1.0	1.0	3.0	1.67	4.0			1.33
	SR10									1.0			0.33				
	SI4					21.0	16.0	15.0	17.33	53.0	100.0	48.0	67.00	9.0			3.00
	SC1	28.0	21.0	33.0	27.33	1.0	1.0	4.0	2.00	10.0	2.0	2.0	4.67	1.0			0.33
	SC2	3.0	4.0		2.33					1.0		1.0	0.67				
Mucous Membrane Tubes	MM13		3.0		1.00					2.0	1.0	2.0	1.67	14.0	9.0		7.67
	MM17													1.0			0.33
	MM9		1.0		0.33			1.0	0.33								
	MM15											8.0	2.67				
	PC2		2.0		0.67	1.0			0.33								

Density of Worm Tubes, Elliott Bay
December 8,9. 1976

		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1											6.0	2.0				
	MF5	1.0			0.33			1.0	0.33					2.0	3.0	2.0	2.33
	MF6						5.0	2.0	2.33	1.0		3.0	1.33		6.0		2.00
	MF9					6.0	1.0	1.0	2.67	5.0		2.0	2.33				
	MF10						1.0		0.33								
	MR3		2.0	2.0	1.33	1.0			0.33	5.0	4.0	8.00	5.67	6.0	3.0	4.0	4.33
	MR6														1.0		0.33
	MR7														1.0		0.33
	MR15											1.00	0.33				
Sand Tubes	SF9		2.0	2.0	1.33	2.0			0.67								
	SR1	19.0	237.0	47.0	101.00	93.0	62.0	1.0	52.00						2.0		0.57
	SR3		1.0		0.33		4.0	1.0	1.67								
	SR4		5.0	10.0	5.00		1.0	13.0	4.67							8.0	2.67
	SR5		1.0	2.0	1.00												
	SR7	29.0	34.0	34.0	22.00	100.0	97.0	11.0	69.33	70.0	28.0	19.00	39.0	93.0	12.0	19.0	42.11
	SR8	3.0			1.00	15.0	9.0	2.0	8.67	32.0	32.0	46.00	36.67	71.0	30.0	52.0	51.00
	SR10	5.0	33.0	13.0	17.00	31.0	50.0		27.00						1.0		0.33
	SR14	1.0	2.0	6.0	3.00	6.0	2.0	2.0	3.33								
	SR15		1.0		0.33						1.0		0.33				
	SC1	22.0	5.0		9.00	14.0	14.0	13.0	13.67	37.0	26.0	75.00	46.0	70.0	82.0	54.0	68.67
	SC2		3.0		1.00			2.0	0.67	2.0	6.0		2.67				
Mucous Membrane Tubes	MM1													1.0			0.33
	MM3			6.0	2.00	3.0	7.0		3.33		4.0	6.00	3.33	4.0	5.0	4.0	4.33
	MM4						1.0		0.33								
	MM9	1.0	1.0		0.67						2.0		0.67				
	PC1		7.0	1.0	2.67												
	PC2			10.0	3.33	7.0	7.0		4.67		1.0	2.00	1.0	2.0	1.0	1.0	1.33
	PC3	1.0			0.33	2.0			0.67								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata		4.0 (.058)	4.0 (.192)	2.67 (.0833)		1.0 (.022)		0.33 (.0073)			1.0 (.073)	0.33 (.0243)		3.0 (.132)	1.0 (.130)	1.33 (.0873)
	Glycera tessetata													2.0 (.087)			0.67 (.0290)
Goniadidae	Glycinde picta		1.0 (.036)		0.33 (.0120)	1.0 (.002)			0.33 (.0007)						1.0 (.005)		0.33 (.0017)
Lumbrineridae	Lumbrineris luti		5.0 (.034)	1.0 (.024)	2.00 (.0193)									2.0 (.011)	1.0 (.008)		1.00 (.0063)
	Ninoe gemma						1.0 (.172)		0.33 (.0573)						1.0 (.021)	1.0 (.041)	0.67 (.0207)
Nephtyidae	Nephtys ferruginea	2.0 (.061)	4.0 (.086)	3.0 (.139)	3.00 (.0953)		1.0 (.020)		0.33 (.0067)		1.0 (.025)	2.0 (.122)	1.00 (.0490)	1.0 (.002)	4.0 (.071)	2.0 (.027)	2.33 (.0333)
Onuphidae	Onuphis iridescens		1.0 (.072)		0.33 (.0240)									2.0 (.338)		1.0 (.141)	1.00 (.1597)
Phyllodocidae	Eteone sp.		1.0 (.006)		0.33 (.0027)			1.0 (.005)	0.33 (.0017)								
	Phyllodoce groenlandica	1.0 (.043)		1.0 (.029)	0.67 (.0240)												
	Phyllodoce williamsi		1.0 (.006)		0.33 (.0020)			1.0 (.008)	0.33 (.0026)	1.0 (.035)			0.33 (.0116)		1.0 (.005)		0.33 (.0017)
Polynoidae	Unknown sp.			1.0 (.010)	0.33 (.0033)												
	Unknown sp.													1.0 (.012)			0.33 (.0040)

45

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Errantia																	
Sigalionidae	Pholoe minuta													1.0 (.002)			0.33 (.0007)
Syllidae	Syllis harti		1.0 (.003)		0.33 (.0010)												
	Unknown sp.													1.0 (.010)			0.33 (.0033)

(Column group heading: Replicate and Mean Density and Biomass*)

46

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Amphicties scaphobranchiata		1.0 (.028)	1.0 (.004)	0.67 (.0107)							1.0 (.002)	0.33 (.0007)	5.0 (.015)	12.0 (.023)	2.0 (.004)	6.33 (.0140)
Capitellidae	Heteromastus cf. filoformis	4.0 (.161)	12.0 (2.267)	28.0 (4.735)	14.67 (2.3877)		4.0 (.066)	6.0 (.265)	3.33 (.1103)	1.0 (.034)		2.0 (.042)	1.0 (.0253)	3.0 (.170)	8.0 (.353)	8.0 (.926)	6.33 (.4830)
Chaetopteridae	Unknown sp.					1.0 (.003)			0.33 (.001)								
Cirratulidae	Tharyx sp.	1.0 (.004)		1.0 (.083)	0.67 (.0290)									1.0 (.003)			0.33 (.0010)
Disomidae	Trochochaeta multisetosa		1.0 (.003)		0.33 (.0010)	2.0 (.013)			0.67 (.0043)		1.0 (.003)	1.0 (.005)	0.67 (.0027)	1.0 (.005)			0.33 (.0017)
Cossuridae	Unknown sp.		2.0 (.001)		0.67 (.0003)												
Maldanidae	Asychis similis						1.0 (1.186)		0.33 (.3953)					1.0 (.123)			0.33 (.0410)
	Euclymene zonalis	3.0 (.058)	41.0 (.719)	16.0 (.298)	20.00 (.3583)	1.0 (.015)		1.0 (.009)	0.67 (.0080)			1.0 (.005)	0.33 (.0017)	5.0 (.109)	12.0 (1.364)	9.0 (.106)	8.67 (.5263)
	Rhodine bitorquata		1.0 (.028)	1.0 (.041)	0.67 (.0230)												
	Praxillella affinis	2.0 (.690)			0.67 (.2300)												
	Praxillella gracilis		2.0 (.162)	1.0 (.065)	1.00 (.0757)							1.0 (.244)	0.33 (.0813)			1.0 (.049)	0.33 (.0163)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum Class Subclass Order Family	Scientific Name	Station 1 1	Station 1 2	Station 1 3	Station 1 $\bar{x}$	Station 2 1	Station 2 2	Station 2 3	Station 2 $\bar{x}$	Station 3 1	Station 3 2	Station 3 3	Station 3 $\bar{x}$	Station 4 1	Station 4 2	Station 4 3	Station 4 $\bar{x}$
Sedentaria																	
Opheliidae	Ammotrypane aulogaster	7.0 (.119)	11.0 (.215)	7.0 (.068)	8.33 (.1340)		2.0 (.005)	5.0 (.085)	2.33 (.0300)	8.0 (.125)	4.0 (.058)	8.0 (.088)	6.67 (.0903)	2.0 (.033)	2.0 (.032)	1.0 (.019)	1.67 (.0280)
Oweniidae	Myriochele heeri													1.0 (.008)			0.33 (.0027)
	Owenia fusiformis													1.0 (.007)			0.33 (.0023)
Paraonidae	Aricidea longicornuta		3.0 (.005)	2.0 (.005)	1.67 (.0033)									3.0 (.008)			1.00 (.0027)
	Paraonella spinifera													1.0 (.001)			0.33 (.0003)
Pectinariidae	Pectinaria granulata		1.0 (.105)	1.0 (.046)	0.67 (.0503)												
Spionidae	Polydora uncata							1.0 (.002)	0.33 (.0007)	1.0 (.010)	6.0 (.026)	5.0 (.041)	4.00 (.0257)		1.0 (.002)		0.33 (.0007)
	Laonice cirrata	1.0 (.421)	3.0 (.044)	1.0 (.286)	1.67 (.2503)		4.0 (1.981)		1.33 (.6603)					2.0 (.006)	2.0 (.139)	1.0 (.116)	1.67 (.3870)
	Prionospio malmgreni		6.0 (.013)	1.0 (.008)	2.33 (.007)							1.0 (.004)	0.33 (.0013)	6.0 (.006)	4.0 (043)	1.0 (.021)	3.67 (.0233)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.		1.0 (.002)		0.33 (.0007)												
	Mitrella gouldi		3.0 (.141)		1.00 (.0470)									1.0 (.018)	1.0 (.100)		0.67 (.0393)
	Polinices sp.			1.0 (1.607)	0.33 (.5357)												
Opisthobranchia	Odostomia			1.0 (.004)	0.33 (.0013)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda	Axinopsida serricata	41.0 (.416)	229.0 (1.514)	214.0 (1.584)	161.33 (1.1713)	3.0 (.016)	79.0 (.564)	7.0 (.048)	29.67 (.2093)			1.0 (.003)	0.33 (.0010)	53.0 (.425)	147.0 (1.131)	50.0 (.450)	83.33 (.6683)
	Cardiomya oldroydi		1.0 (.013)	1.0 (.008)	0.67 (.0070)												
	Compsomyax subdiaphana		1.0 (.050)		0.33 (.0167)												
	Lucinoma annulata		2.0 (.277)	1.0 (.056)	1.00 (.1110)												
	Macoma alaskansis	4.0 (.129)		1.0 (.106)	1.67 (.0783)		1.0 (.044)		0.33 (.0147)	2.0 (.303)			0.67 (.1010)	1.0 (.034)	1.0 (.058)		0.67 (.0307)
	Macoma carlottensis		13.0 (.252)		4.33 (.0840)		4.0 (.063)		1.33 (.0210)			3.0 (.006)	1.0 (.0020)	18.0 (.324)	19.0 (.396)	19.0 (.402)	18.67 (.3740)
	unknown Macoma sp.							1.0 (.001)	0.33 (.0003)								
	Nucula tenuis		2.0 (.057)	3.0 (.042)	1.67 (.0330)		2.0 (.042)		0.67 (.0140)					1.0 (.010)	2.0 (.015)		1.00 (.0083)
	Nuculana minuta			4.0 (.072)	1.33 (.0240)					1.0 (.070)		2.0 (.050)	1.00 (.0400)				
	Nuculana fossa														1.0 (.210)		0.33 (.0700)
	Yoldia sp.															2.0 (.036)	0.67 (.0120)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

		Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA																	
	Density	3.0	18.0	10.0	10.32	1.0	3.0	2.0	1.98	1.0	1.0	3.0	1.66	10.0	11.0	5.0	8.65
	Biomass	.104	.303	.394	.2669	.002	.214	.013	.0736	.035	.025	.195	.0849	.462	.242	.339	.3477
	Number of species	2.0	8.0	5.0	5.0	1.0	3.0	2.0	2.0	1.0	1.0	2.0	1.33	7.0	6.0	4.0	5.67
SEDENTARIA	Density	18.0	84.0	60.0	54.02	4.0	11.0	13.0	9.32	10.0	11.0	20.0	13.66	32.0	41.0	23.0	31.98
	Biomass	1.453	3.590	5.639	3.5606	.031	3.238	.361	1.2099	.169	.087	.431	.2290	1.394	1.956	1.241	1.5303
	Number of species	6.0	12.0	11.0	9.67	3.0	4.0	4.0	3.67	3.0	3.0	8.0	4.67	13.0	7.0	7.0	9.00
GASTROPODA	Density		4.0	2.0	2.00									1.0	1.0		0.67
	Biomass		.143	1.161	.5847									.018	.100		.0393
	Number of species		2.0	2.0	1.33									1.0	1.0		0.67
PELECYPODA	Density	45.0	248.0	224.0	172.33	3.0	86.0	8.0	32.33	3.0		6.0	3.0	73.0	170.0	71.0	104.67
	Biomass	.545	2.163	1.868	1.5253	.016	.713	.049	.2593	.373		.059	.1440	.792	1.810	.888	1.1633
	Number of species	2.0	6.0	6.0	4.67	1.0	4.0	2.0	2.33	2.0		3.0	1.67	4.0	5.0	3.0	4.0
TOTAL	Density	66.0	354.0	296.0	238.67	8.0	100.0	23.0	43.63	14.0	12.0	29.0	18.32	116.0	223.0	99.0	145.97
	Biomass	2.102	6.199	9.512	5.9375	.049	4.165	.423	1.5455	.577	.112	.685	.4579	2.666	4.108	2.468	3.0806
	Number of species	10.0	28.0	24.0	20.67	5.0	11.0	8.0	8.0	6.0	4.0	13.0	7.67	25.0	19.0	14.0	19.34

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5: 1	Station 5: 2	Station 5: 3	Station 5: x̄	Station 6: 1	Station 6: 2	Station 6: 3	Station 6: x̄	Station 7: 1	Station 7: 2	Station 7: 3	Station 7: x̄	Station 8: 1	Station 8: 2	Station 8: 3	Station 8: x̄
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Errantia																	
Dorvillidae	Unknown sp.							1.0 (.010)	0.33 (.0033)								
Glyceridae	*Glycera capitata*		4.0 (.294)	5.0 (.152)	3.00 (.1437)	2.0 (.005)	1.0 (.043)	3.0 (.247)	2.00 (.0983)	1.0 (.003)			0.33 (.0010)	3.0 (.137)	2.0 (.075)	2.0 (.065)	2.33 (.0923)
**Lumbrineridae	*Lumbrineris luti*		1.0 (.003)	3.0 (.049)	1.33 (.0173)	2.0 (.009)		1.0 (.007)	1.00 (.0053)		2.0 (.007)		0.67 (.0023)	6.0 (.041)	1.0 (.014)	1.0 (.005)	2.67 (.0200)
	Ninoe gemma			1.0 (.073)	0.33 (.0243)												
Nephtyidae	*Nephtys ferruginea*		2.0 (.019)	5.0 (.117)	2.33 (.0453)	2.0 (.040)	1.0 (.005)		1.00 (.0150)	1.0 (.012)			0.33 (.0040)	4.0 (.085)	3.0 (.100)	3.0 (.073)	3.33 (.0860)
Onuphidae	*Diaptra ornatus*			2.0 (.333)	0.67 (.1110)												
	Onuphis iridescens					1.0 (.020)		4.0 (.279)	1.67 (.0997)					2.0 (.140)	2.0 (.372)	1.0 (.135)	1.67 (.2157)
Phyllodocidae	*Eteone* sp.							1.0 (.003)	0.33 (.0010)								
	Phyllodoce williamsi		1.0 (.003)		0.33 (.0010)	1.0 (.007)	2.0 (.013)	1.0 (.006)	1.33 (.0087)	3.0 (.042)		1.0 (.010)	1.33 (.0173)	1.0 (.010)		1.0 (.004)	0.67 (.0047)
Polynoidae	Unknown sp.		1.0 (.007)		0.33 (.0023)	1.0 (.004)			0.33 (.0013)					1.0 (.001)			0.33 (.0003)
**Goniadidae	*Glycinde picta*		1.0 (.002)	1.0 (.003)	0.67 (.0017)	1.0 (.035)		1.0 (.003)	0.67 (.0127)					2.0 (.014)			0.67 (.0047)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass* Station 5: 1	Station 5: 2	Station 5: 3	Station 5: x̄	Station 6: 1	Station 6: 2	Station 6: 3	Station 6: x̄	Station 7: 1	Station 7: 2	Station 7: 3	Station 7: x̄	Station 8: 1	Station 8: 2	Station 8: 3	Station 8: x̄
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Amphicteis scaphobranchiata		4.0 (.012)	2.0 (.021)	2.00 (.0110)	2.0 (.012)	1.0 (.001)		1.00 (.0043)		2.0 (.004)		0.67 (.0013)	4.0 (.007)	5.0 (.016)	2.0 (.002)	3.67 (.0083)
Capitellidae	Heteromastus cf. filoformis		3.0 (.127)	2.0 (.402)	1.67 (.1763)	5.0 (.295)	1.0 (.039)	13.0 (.623)	6.33 (.3190)					6.0 (.170)	6.0 (.573)	17.0 (.871)	9.67 (.5380)
Cirratulidae	Tharyx sp.			1.0 (.008)	0.33 (.0027)												
Disomidae	Trochochaeta multisetosa			1.0 (.004)	0.33 (.0013)			1.0 (.018)	0.33 (.0060)					3.0 (.006)			1.00 (.0020)
Cossuridae	Unknown sp.						1.0 (.003)		0.33 (.0010)								
Maldanidae	Euclymene zonalis		24.0 (.552)	9.0 (.343)	11.0 (.2983)	1.0 (.001)	1.0 (.028)	12.0 (.265)	4.67 (.0980)					5.0 (.168)	7.0 (.192)	3.0 (.025)	5.00 (.1283)
	Praxillella gracilis		1.0 (.050)	1.0 (.067)	0.67 (.0390)									1.0 (.201)	1.0 (.346)	1.0 (.182)	1.00 (.2430)
Opheliidae	Ammotrypane aulogaster	2.0 (.014)	4.0 (.037)	3.0 (.038)	3.00 (.0297)	2.0 (.052)		3.0 (.040)	1.67 (.0307)	14.0 (.183)	22.0 (.313)	8.0 (.084)	14.67 (.1933)	1.0 (.014)		1.0 (.015)	0.67 (.0097)
Oweniidae	Owenia fusiformis					1.0 (.002)		1.0 (.002)	0.67 (.0013)	2.0 (.005)			0.67 (.0017)				
Paraonidae	Aricidea longicornuta			1.0 (.003)	0.33 (.0010)		2.0 (.008)	1.0 (.003)	1.00 (.0037)					5.0 (.006)			1.67 (.0020)
	Paraonella spinifera							1.0 (.001)	0.33 (.0003)					3.0 (.002)			1.00 (.0007)
Pectinariidae	Pectinaria granulata			3.0 (.269)	1.00 (.0897)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5: 1	Station 5: 2	Station 5: 3	Station 5: x̄	Station 6: 1	Station 6: 2	Station 6: 3	Station 6: x̄	Station 7: 1	Station 7: 2	Station 7: 3	Station 7: x̄	Station 8: 1	Station 8: 2	Station 8: 3	Station 8: x̄
		Replicate and Mean Density and Biomass*															
Sedentaria																	
Spionidae	Polydora uncata	6.0 (.028)	9.0 (.055)	5.0 (.020)	6.67 (.0343)		15.0 (.108)	2.0 (.007)	5.67 (.0383)	34.0 (.231)	38.0 (.207)	49.0 (.209)	40.33 (.2157)		1.0 (.001)	2.0 (.004)	1.00 (.0017)
	Laonice cirrata		2.0 (.781)	2.0 (1.179)	1.33 (.6533)	1.0 (.015)			0.33 (.0050)						4.0 (.365)		1.33 (.1217)
	Prionospio malmgreni		5.0 (.005)		1.67 (.0017)		4.0 (.007)	1.0 (.007)	1.67 (.0047)	3.0 (.009)			1.00 (.0030)	2.0 (.011)		5.0 (.011)	2.33 (.0073)
	Prionospio pinnata									1.0 (.003)			0.33 (.0010)				
Terebellidae	Unknown sp.									1.0 (.003)			0.33 (.001)				
Trichobranchus																	
	Trichobranchus glacilis													1.0 (.019)			0.33 (.0063)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Mitrella sp.									2.0 (.187)		1.0 (.057)	1.00 (.0813)		1.0 (.001)		0.33 (.0003)
	Polinices sp.													1.0 (.051)			0.33 (.0170)
Opisthobranchia	Turbonilla sp.							1.0 (.005)	0.33 (.0017)						1.0 (.002)		0.33 (.0007)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Pelecypoda (Bivalvia)	Axinopsida serricata		149.0 (1.034)	68.0 (.568)	72.33 (.5340)	5.0 (.032)	4.0 (.033)	106.0 (.865)	38.33 (.3100)					7.0 (.047)			2.33 (.0157)
	Macoma alaskansis		2.0 (.221)	2.0 (.472)	1.33 (.231)		3.0 (.822)	1.0 (.496)	1.33 (.4393)								
	Macoma carlottensis		16.0 (.451)	9.0 (.317)	8.33 (.2560)	3.0 (.009)	1.0 (.013)	8.0 (.178)	4.00 (.0667)	6.0 (.050)	3.0 (.037)	2.0 (.017)	3.67 (.0347)	2.0 (.009)	6.0 (.068)	4.0 (.152)	4.00 (.0763)
	Macoma calcarea															1.0 (.237)	0.33 (.0790)
	Nucula tenuis		1.0 (.007)	3.0 (.015)	1.33 (.0073)												

AD-A058 442 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 13/2
AQUATIC DISPOSAL FIELD INVESTIGATIONS, DUWAMISH WATERWAY DISPOS--ETC(U)
JUN 78 R A HARMAN, J C SERWOLD WESRS-76-90

UNCLASSIFIED WES-TR-D-77-24-APP-F NL

4 OF 5
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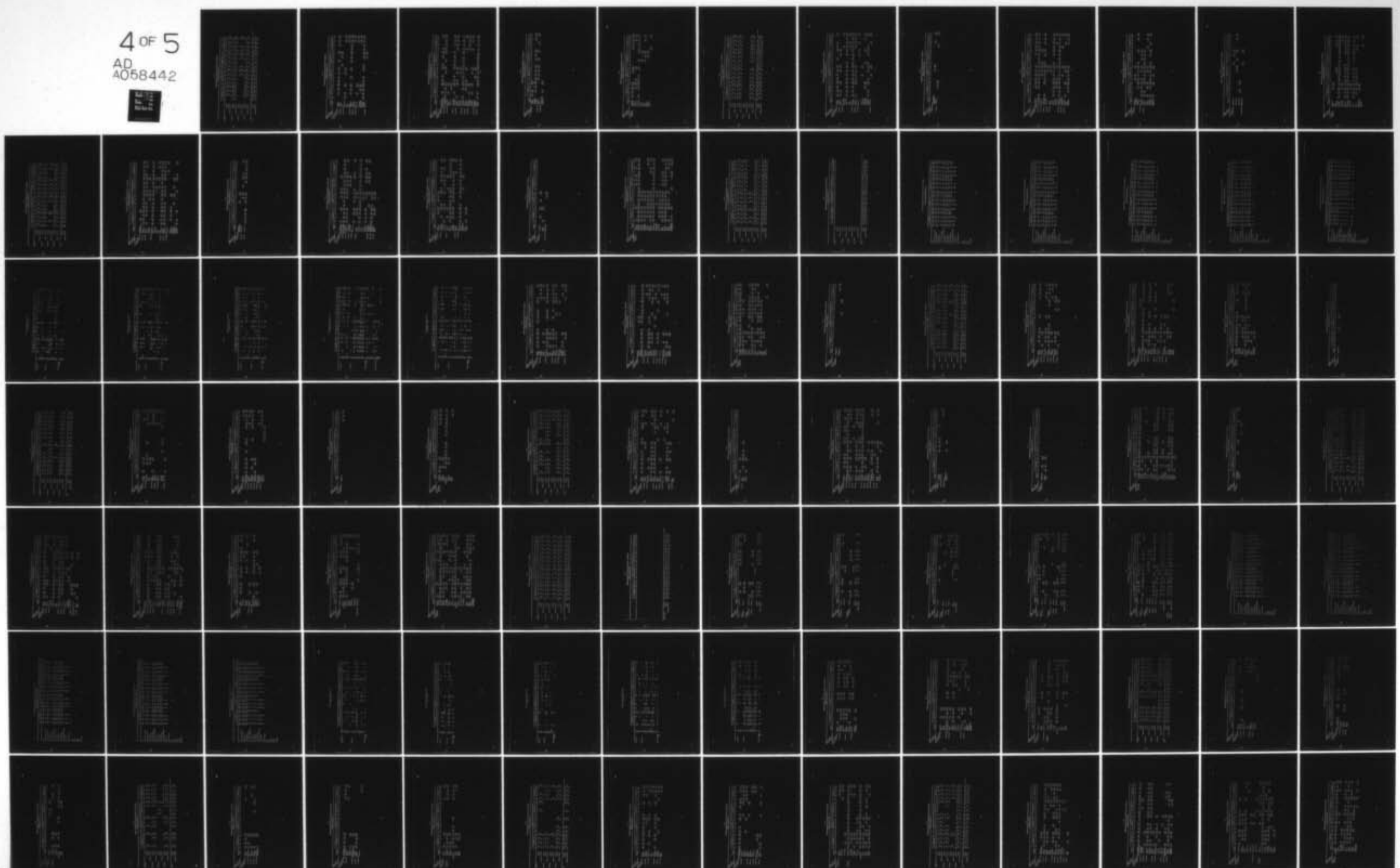

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

		Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ERRANTIA	Density		10.0	17.0	8.99	10.0	4.0	12.0	8.66	5.0	2.0	1.0	2.66	19.0	8.0	8.0	11.67
	Biomass		.328	.727	.3516	.120	.061	.555	.2453	.057	.007	.010	.0246	.428	.561	.282	.4237
	Number of species		6.0	6.0	4.00	7.0	3.0	7.0	5.67	3.0	1.0	1.0	1.67	7.0	4.0	5.0	5.33
SEDENTARIA	Density	8.0	52.0	30.0	30.00	12.0	25.0	35.0	24.0	55.0	62.0	57.0	58.0	31.0	24.0	31.0	28.67
	Biomass	.042	1.619	2.354	1.3383	.377	.194	.966	.5123	.434	.524	.293	.4170	.604	1.493	1.110	1.0690
	Number of species	2.0	8.0	11.0	7.00	6.0	7.0	9.0	7.33	6.0	3.0	2.0	3.67	10.0	6.0	7.0	7.67
GASTROPODA	Density							1.0	0.33	2.0		1.0	1.00	1.0	2.0		1.00
	Biomass							.005	.0017	.187		.057	.0813	.051	.003		.0180
	Number of species							1.0	0.33	1.0		1.0	0.67	1.0	1.0		0.67
TELECYPODA	Density		168.0	82.0	83.32	8.0	8.0	115.0	43.66	6.0	3.0	2.0	3.67	9.0	6.0	5.0	6.67
	Biomass		1.713	1.372	1.0283	.041	.868	1.5390	.8160	.050	.037	.017	.0347	.056	.068	.389	.1710
	Number of species		4.0	4.0	2.67	2.0	3.0	3.0	2.67	1.0	1.0	1.0	1.00	2.0	1.0	2.0	1.67
TOTAL	Density	8.0	230.0	129.0	122.31	30.0	37.0	163.0	76.66	68.0	67.0	61.0	65.33	60.0	40.0	44.00	48.00
	Biomass	.042	3.660	4.453	2.7182	.538	1.123	3.065	1.5753	.728	.568	.377	.5576	1.139	2.125	1.781	1.6817
	Number of species	2.0	18.0	21.0	13.67	15.0	13.0	20.0	16.0	11.0	5.0	5.0	7.01	20.0	12.0	14.0	15.34

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*		5.0 (.211)	1.0 (.075)	2.00 (.0953)	2.0 (.005)	1.0 (.001)	1.0 (.002)	1.33 (.0027)		2.0 (.003)		0.67 (.0010)		1.0 (.012)	1.0 (.016)	0.67 (.0093)
Goniadidae	*Glycinde picta*									1.0 (.007)		1.0 (.002)	0.67 (.0030)				
Lumbrineridae	*Lumbrineris luti*	1.0 (.015)	1.0 (.009)		0.67 (.0080)			3.0 (.005)	1.00 (.0017)							5.0 (.018)	1.67 (.0060)
	Ninoe gemma															1.0 (.019)	0.33 (.0063)
Nephtyidae	*Nephtys ferruginea*		5.0 (.164)	2.0 (.089)	2.33 (.0843)		5.0 (.007)		1.67 (.0023)		2.0 (.012)	2.0 (.003)	1.33 (.0050)	2.0 (3.815)	5.0 (.125)	2.0 (.040)	3.00 (1.3267)
Onuphidae	*Onuphis iridescens*															1.0 (.110)	0.33 (.0367)
Phyllodocidae	*Eteone* sp.		1.0 (.009)		0.33 (.0030)											2.0 (.004)	0.67 (.0013)
	Phyllodoce groenlandica			1.0 (.008)	0.33 (.0027)											1.0 (.088)	0.33 (.0293)
	Phyllodoce williamsi	2.0 (.046)	2.0 (.028)	1.0 (.008)	1.67 (.0273)	1.0 (.007)	2.0 (.018)		1.00 (.0083)	1.0 (.001)		3.0 (.008)	1.33 (.0030)	1.0 (.005)	1.0 (.007)	2.0 (.015)	1.33 (.0090)
Polynoidae	Unknown sp.											1.0 (.001)	0.33 (.0003)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Amphicteis schapnobranchiata		6.0 (.018)		2.00 (.0060)	1.0 (.002)	2.0 (.002)		1.00 (.0013)	1.0 (.002)		4.0 (.003)	1.67 (.0017)	5.0 (.013)			1.67 (.0043)
Capitellidae	Heteromastus cf. filiformis	3.0 (.113)	1.0 (.128)	1.0 (.025)	1.67 (.0887)			1.0 (.095)	0.33 (.0317)		1.0 (.003)		0.33 (.0010)	13.0 (.206)	8.0 (.332)	11.0 (.255)	10.67 (.2643)
Cirratulidae	Chaetozone setosa		1.0 (.005)		0.33 (.0017)												
	Tharyx sp.			1.0 (.002)	0.33 (.0007)												
Disomidae	Trochochaeta multisetosa		1.0 (.002)		0.33 (.0007)	1.0 (.001)	3.0 (.020)		1.33 (.0070)	2.0 (.010)	1.0 (.005)	2.0 (.006)	1.67 (.0070)		1.0 (.001)	4.0 (.028)	1.67 (.0097)
Maldanidae	Euclymene zonalis	4.0 (.027)			1.33 (.0090)	1.0 (.006)		2.0 (.005)	1.00 (.0037)					3.0 (.037)	3.0 (.031)	1.0 (.003)	2.33 (.0237)
	Praxilella gracilis							1.0 (.290)	0.33 (.0967)								
Opheliidae	Ammotrypane aulogaster	6.0 (.076)		5.0 (.076)	3.67 (.0507)	22.0 (.391)	20.0 (.246)	3.0 (.028)	15.0 (.2217)	2.0 (.006)	17.0 (.176)	10.0 (.067)	9.67 (.0830)	2.0 (.030)	3.0 (.056)	3.0 (.048)	2.67 (.0447)
Oweniidae	Owenia fusiformis			1.0 (.006)	0.33 (.002)	1.0 (.005)			0.33 (.0017)					1.0 (.002)			0.33 (.0007)
Paraonidae	Aricidea longicornuta		1.0 (.007)		0.33 (.0023)									2.0 (.005)	1.0 (.002)	4.0 (.010)	2.33 (.0057)
	Paraonella spinifera		1.0 (.001)		0.33 (.0003)			3.0 (.002)	1.00 (.0007)					1.0 (.001)		6.0 (.010)	2.33 (.0037)
Pectinariidae	Pectinaria granulata						2.0 (.002)		0.67 (.0007)								
Spionidae	Polydora uncata	11.0 (.174)	5.0 (.045)		5.33 (.0730)	10.0 (.050)	86.0 (.427)	5.0 (.022)	33.67 (.1663)	18.0 (.055)	26.0 (.130)	69.0 (.382)	37.67 (.1890)	9.0 (.041)	1.0 (.004)	2.0 (.010)	4.00 (.0183)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Spionidae	Laonice cirrata	1.0 (.110)	1.0 (.002)		0.67 (.0373)												
	Prionospio malmgreni		4.0 (.007)	1.0 (.008)	1.67 (.0050)	1.0 (.003)	1.0 (.001)	3.0 (.015)	1.67 (.0063)		1.0 (.007)	2.0 (.012)	1.00 (.0063)			2.0 (.007)	0.67 (.0023)
Terebellidae	Artacama conifer					1.0 (.010)	1.0 (.027)	1.0 (.090)	1.00 (.0423)		1.0 (.003)		0.33 (.001)		1.0 (.088)		0.33 (.0293)
Trichobranchidae																	
	Trichobranchus glacilis		1.0 (.004)		0.33 (.0013)												

Table

<u>Density and Biomass of Benthic Assemblages, Elliott Bay</u>

<u>Sampled 15 September 1976</u>

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Pelecypoda (Bivalvia)	*Axinopsida serricata*	26.0 (.160)	18.0 (.123)	28.0 (.203)	24.00 (.1620)			2.0 (.010)	0.67 (.0033)					15.0 (.082)	7.0 (.035)	10.0 (.067)	10.67 (.0613)
	Macoma alaskansis			1.0 (.040)	0.33 (.0133)	1.0 (.024)			0.33 (.0080)							3.0 (.292)	1.00 (.0973)
	Macoma carlottensis	4.0 (.108)		3.0 (.006)	2.33 (.0380)	2.0 (.047)	2.0 (.011)		1.33 (.0193)		2.0 (.045)		0.67 (.0150)	11.0 (.121)	5.0 (.043)	5.0 (.061)	7.00 (.0750)
	Mytilus edulis										1.0 (.007)		0.33 (.0023)				
	Nucula tenuis										1.0 (.012)	1.0 (.070)	0.67 (.0273)			1.0 (.010)	0.33 (.0033)
	Nuculana minuta											1.0 (.014)	0.33 (.0047)				
	Yoldia sp.													1.0 (1.060)			0.33 (.3533)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

		Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
RANTIA	Density	3.0	14.0	5.0	7.33	3.0	8.0	4.0	5.00	2.0	4.0	7.0	4.33	3.0	7.0	15.0	8.33
	Biomass	.061	.421	.180	.2206	.012	.026	.007	.0150	.008	.015	.014	.0123	3.82	.144	.310	1.4246
	Number of species	2.0	5.0	4.0	3.67	2.0	3.0	2.0	2.33	2.0	2.0	4.0	2.67	2.0	3.0	8.0	4.33
ENTARIA	Density	25.0	22.0	9.0	18.65	38.0	115.0	19.0	57.33	23.0	47.0	87.0	52.34	36.0	18.0	33.0	29.00
	Biomass	.500	.219	.117	.2784	.468	.725	.547	.5801	.073	.324	.470	.2890	.335	.514	.371	.4067
	Number of species	5.0	10.0	5.0	6.67	8.0	7.0	8.0	7.67	4.0	6.0	5.0	5.0	8.0	7.0	8.0	7.67
STROPODA	Density																
	Biomass																
	Number of species																
LECYPODA	Density	30.0	18.0	32.0	26.66	3.0	2.0	2.0	2.33		4.0	2.0	2.0	27.0	12.0	19.0	19.33
	Biomass	.268	.123	.249	.2133	.071	.011	.010	.0306		.064	.084	.0493	1.2630	.078	.430	.5902
	Number of species	2.0	1.0	3.0	2.00	2.0	1.0	1.0	1.33		3.0	2.0	1.67	3.0	2.0	4.0	3.00
AL	Density	58.0	54.0	46.0	52.64	44.0	125.0	25.0	64.66	25.0	55.0	96.0	58.67	66.0	37.0	67.0	56.66
	Biomass	.829	.763	.546	.7123	.551	.762	.564	.6257	.081	.403	.568	.3506	5.418	.736	1.111	2.4215
	Number of species	9.0	16.0	12.0	12.34	12.0	11.0	11.0	11.33	6.0	11.0	11.0	9.34	13.0	12.0	20.0	15.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	2.0 (.040)	3.0 (.230)	2.0 (.090)	2.33 (.1200)	3.0 (.069)	4.0 (.210)	3.0 (.180)	3.33 (.1530)		1.0 (.025)		0.33 (.0083)	2.0 (.279)	3.0 (.100)		1.67 (.1263)
Goniadidae	Glycinde picta	1.0 (.005)	2.0 (.004)		1.00 (.0030)			1.0 (.002)	0.33 (.0007)			1.0 (.075)	0.33 (.0250)				
Lumbrineridae	Lumbrineris bicirrata													1.0 (.780)			0.33 (.2600)
	Lumbrineris luti	2.0 (.037)	2.0 (.018)	3.0 (.028)	2.33 (.0277)	3.0 (.023)	2.0 (.024)	1.0 (.008)	2.00 (.0183)	1.0 (.003)		1.0 (.008)	0.67 (.0037)	2.0 (.004)	4.0 (.048)	1.0 (.002)	2.33 (.0180)
	Ninoe gemma													1.0 (.023)	1.0 (.032)		0.67 (.0183)
Nephytidae	Nephtys ferruginea	2.0 (.055)	3.0 (.032)	3.0 (.092)	2.67 (.0597)	1.0 (.022)	4.0 (.088)	4.0 (.088)	3.00 (.0660)	2.0 (.003)	2.0 (.058)	2.0 (.060)	2.00 (.0403)	3.0 (.032)	2.0 (.030)	6.0 (.185)	3.67 (.0823)
Onuphidae	Onuphis iridescens	1.0 (.222)			0.33 (.0740)	1.0 (.115)	1.0 (.125)	1.0 (.082)	1.00 (.1073)					1.0 (.200)	1.0 (.212)	1.0 (.246)	1.00 (.2193)
Phyllodocidae	Eteone sp.											1.0 (.004)	0.33 (.0013)		3.0 (.013)		1.00 (.0043)
	Eulalia leuicornuta						1.0 (.005)		0.33 (.0017)								
	Phyllodoce groenlandica			2.0 (.198)	0.67 (.0660)					1.0 (.058)			0.33 (.0193)			1.0 (.027)	0.33 (.0090)
	Phyllodoce williamsi	1.0 (.050)	5.0 (.052)		2.00 (.0340)	3.0 (.125)		1.0 (.006)	1.33 (.0437)	4.0 (.062)		1.0 (.042)	1.67 (.0347)	1.0 (.018)			0.33 (.0060)
Polynoidae	Unknown sp.						1.0 (.014)		0.33 (.0047)						1.0 (.003)		0.33 (.0010)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Errantia																	
Sphaeroidoridae																	
	Sphaerodoropsis sphaeruli							1.0 (.001)	0.33 (.0003)						2.0 (.002)		0.67 (.0007)
Syllidae	Unknown sp.			1.0 (.001)	0.33 (.0003)									1.0 (.005)			0.33 (.0017)

64

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Amphicties scaphobranchiata			1.0 (.005)	0.33 (.0017)	3.0 (.005)	5.0 (.020)	2.0 (.005)	3.33 (.0100)			1.0 (.002)	0.33 (.007)	3.0 (.013)	7.0 (.020)	2.0 (.007)	4.00 (.0133)
Capitellidae	Heteromastus cf. filoformis	11.0 (.490)		13.0 (1.180)	8.0 (.5567)	5.0 (.345)	9.0 (.219)	9.0 (.295)	7.67 (.2863)	4.0 (.205)	3.0 (.336)	2.0 (.175)	3.00 (.2387)	6.0 (.368)	16.0 (.543)	3.0 (.136)	8.33 (.3490)
Cirratulidae	Chaetozone setosa						2.0 (.015)	1.0 (.003)	1.00 (.0060)	1.0 (.028)			0.33 (.0093)				
Disomidae	Trochochaeta multisetosa	2.0 (.005)			0.67 (.0017)	1.0 (.003)	1.0 (.006)	1.0 (.002)	1.00 (.0037)	1.0 (.003)		2.0 (.008)	1.00 (.0037)		3.0 (.026)	1.0 (.002)	1.33 (.0093)
Cossuridae	Unknown sp.							3.0 (.004)	1.00 (.0013)								
Maldanidae	Asychis similis							1.0 (.268)	0.33 (.0893)								
	Euclymene zonalis	2.0 (.015)	1.0 (.002)	7.0 (.065)	3.33 (.0273)	2.0 (.014)	3.0 (.046)	2.0 (.012)	2.33 (.0240)	1.0 (.003)		1.0 (.007)	0.67 (.0033)	13.0 (.170)	18.0 (.308)	13.0 (.226)	14.67 (.2347)
	Praxillella gracilis			1.0 (.050)	0.33 (.0167)	1.0 (.490)			0.33 (.1633)						1.0 (.052)		0.33 (.0173)
Opheliidae	Ammotrypane aulogaster	5.0 (.046)	4.0 (.026)	6.0 (.092)	5.00 (.0547)	6.0 (.070)	4.0 (.052)	3.0 (.028)	4.33 (.0500)	5.0 (.102)	5.0 (.028)	6.0 (.109)	5.33 (.0797)	2.0 (.028)	8.0 (.110)	3.0 (.038)	4.33 (.0587)
Orbiniidae	Haploscoloplos elongata						1.0 (.003)		0.33 (.0010)					1.0 (.005)			0.33 (.0017)
Oweniidae	Myriochele heeri	1.0 (.001)			0.33 (.0003)			1.0 (.003)	0.33 (.0010)						2.0 (.013)		0.67 (.0043)
	Owenia fusiformis		1.0 (.003)	1.0 (.003)	0.67 (.0020)	1.0 (.007)	2.0 (.010)	3.0 (.019)	2.00 (.0120)						1.0 (.004)	1.0 (.008)	0.67 (.0040)

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Paraonidae	Aricidea longicornuta					1.0 (.004)	3.0 (.014)		1.33 (.0060)								
	Paraonella spinifera			1.0 (.001)	0.33 (.0003)	1.0 (.001)	1.0 (.001)	1.0 (.001)	1.00 (.0010)	2.0 (.002)			0.67 (.0007)			2.0 (.002)	0.67 (.0007)
Pectinariidae	Pectinaria granulata	1.0 (.052)	1.0 (.007)	2.0 (.097)	1.33 (.0520)	1.0 (.110)		1.0 (.014)	0.67 (.0413)		2.0 (.069)	1.0 (.148)	1.00 (.0723)				
Spionidae	Polydora uncata	2.0 (.009)	32.0 (.277)		11.33 (.0953)	2.0 (.015)	2.0 (.010)	3.0 (.022)	2.33 (.0157)	12.0 (.092)	3.0 (.009)	2.0 (.018)	5.67 (.0397)				
	Laonice cirrata	2.0 (.995)		3.0 (1.052)	1.67 (.6823)			2.0 (.035)	0.67 (.0117)					1.0 (.032)		3.0 (1.102)	1.33 (.3780)
	Prionospio malmgreni	2.0 (.003)		1.0 (.002)	1.00 (.0017)	4.0 (.015)	3.0 (.012)	1.0 (.001)	2.67 (.0093)	3.0 (.010)		3.0 (.012)	2.00 (.0073)		3.0 (.022)		1.00 (.0073)
	Spionophanes cirrata	2.0 (.004)			0.67 (.0013)		1.0 (.004)		0.33 (.0013)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.									2.0 (.001)		1.0 (.001)	1.00 (.0007)				
	Mitrella sp.							1.0 (.048)	0.33 (.0160)		1.0 (.001)		0.33 (.0003)			1.0 (.015)	0.33 (.0050)
	Polinices sp.		1.0 (7.962)		0.33 (2.6540)												
Opisthobranchia	Odostomia sp.									1.0 (.004)			0.33 (.0013)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Pelecypoda (Bivalvai)	Acetocemia exima			1.0 (.030)	0.33 (.0100)												
	Ascila castrensis							1.0 (.008)	0.33 (.0027)						1.0 (.004)	2.0 (.012)	1.00 (.0053)
	Axinopsida serricata	86.0 (.316)	15.0 (.051)	124.0 (.930)	75.00 (.4323)	84.0 (.563)	223.0 (1.255)	206.0 (1.224)	171.00 (1.0140)	23.0 (.133)	15.0 (.038)	15.0 (.108)	17.67 (.0930)	289.0 (1.625)	344.0 (2.265)	297.0 (1.258)	310.00 (1.7160)
	Compsomyax subdiaphana			1.0 (.510)	0.33 (.1700)											1.0 (.029)	0.33 (.0097)
	Macoma alaskansis	5.0 (.053)	1.0 (.041)	8.0 (1.070)	4.67 (.3880)	4.0 (.890)	7.0 (.989)	8.0 (.763)	6.33 (.8807)	2.0 (.597)			0.67 (.1990)	1.0 (.014)	1.0 (.019)	5.0 (.657)	2.33 (.2300)
	Macoma carlottensis	11.0 (.138)	3.0 (.080)	20.0 (.205)	11.33 (.1410)	14.0 (.169)	25.0 (.560)	23.0 (.336)	20.67 (.3550)	1.0 (.006)	3.0 (.039)	1.0 (.050)	1.67 (.0317)	16.0 (.455)	21.0 (.465)	29.0 (.779)	22.00 (.5663)
	Nemocardium sp.			1.0 (.012)	0.33 (.0040)												
	Nucula tenuis	5.0 (.147)	1.0 (.002)	1.0 (.009)	2.33 (.0527)	1.0 (.019)	1.0 (.005)	2.0 (.005)	1.33 (.0097)		2.0 (.051)	2.0 (.152)	1.33 (.0677)	11.0 (.210)	12.0 (.073)	5.0 (.117)	9.33 (.1333)
	Nuculana minuta		3.0 (.091)	5.0 (.142)	2.67 (.0777)	6.0 (.123)	2.0 (.012)	2.0 (.103)	3.33 (.0793)					3.0 (.035)	6.0 (.037)		3.00 (.0240)
	Paravalucina tenuisculptis			1.0 (.082)	0.33 (.0273)												
	Yoldia sp.														1.0 (.054)		0.33 (.0180)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

		Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA																	
	Density	9.0	15.0	11.0	11.66	11.0	13.0	12.0	11.98	8.0	3.0	6.0	5.66	12.0	17.0	9.0	12.66
	Biomass	.409	.336	.409	.3847	.354	.466	.367	.3957	.126	.083	.189	.1326	1.34	.440	.460	.7469
	Number of species	6.0	5.0	5.0	5.33	5.0	6.0	7.0	6.0	4.0	2.0	5.0	3.67	8.0	8.0	4.0	6.67
SEDENTARIA	Density	30.0	39.0	36.0	34.99	28.0	37.0	34.0	32.09	29.0	13.0	18.0	20.0	26.0	59.0	28.0	37.66
	Biomass	1.620	.315	2.547	1.4940	1.079	.412	.712	.7342	.4450	.442	.479	.4554	.616	1.098	1.521	1.0783
	Number of species	10.0	5.0	10.0	8.33	12.0	13.0	15.0	13.33	8.0	4.0	8.0	6.67	6.0	9.0	8.0	7.67
GASTROPODA	Density		1.0		0.33			1.0	0.33	3.0	1.0	1.0	1.66			1.0	0.33
	Biomass		7.062		2.6540			.048	.0160	.005	.001	.001	.0023			.015	.0050
	Number of species		1.0		0.33			1.0	0.33	2.0	1.0	1.0	1.33			1.0	0.33
PELECYPODA	Density	107.0	23.0	162.0	97.32	109.0	258.0	242.0	202.99	26.0	20.0	18.0	21.34	320.0	386.0	339.0	348.32
	Biomass	.654	.265	2.99	1.3030	1.764	2.821	2.439	2.3414	.736	.128	.310	.3914	2.339	2.917	2.852	2.7026
	Number of species	4.0	5.0	9.0	6.00	5.0	5.0	6.0	5.33	3.0	3.0	3.0	3.0	5.0	7.0	6.0	6.00
TOTAL	Density	146.0	78.0	209.0	144.30	148.0	308.0	289.0	248.28	66.0	37.0	43.0	48.66	358.0	462.0	377.0	398.97
	Biomass	2.683	8.878	5.946	5.8357	3.197	3.699	3.566	3.4873	1.312	.6540	.979	.9817	4.295	4.455	4.848	4.5328
	Number of species	20.0	16.0	24.0	20.0	22.0	24.0	29.0	25.00	17.0	10.0	17.0	14.67	19.0	24.0	19.0	20.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Arabellidae	Notocirrus californiensis		1.0 (.200)		0.33 (.0667)												
Glyceridae	Glycera capitata	2.0 (.150)	3.0 (.032)	3.0 (.057)	2.67 (.0797)	2.0 (.020)	4.0 (.038)	3.0 (.026)	3.00 (.0280)	4.0 (.295)	1.0 (.004)	3.0 (.022)	2.67 (.1070)	2.0 (.267)	4.0 (.473)	2.0 (.022)	2.67 (.2540)
Goniadidae	Glycinde picta	1.0 (.126)		1.0 (.230)	0.67 (.1187)	2.0 (.150)	1.0 (.253)		1.00 (.1343)	1.0 (.022)	3.0 (.178)	1.0 (.028)	1.67 (.0760)	3.0 (.512)		1.0 (.063)	1.33 (.1917)
	Goniadidae brunnea							1.0 (.642)	0.33 (.2140)	1.0 (.022)			0.33 (.0073)				
Lumbrineridae	Lumbrineris luti	3.0 (.020)	5.0 (.058)	4.0 (.026)	4.00 (.0347)	2.0 (.008)	4.0 (.028)	4.0 (.028)	3.33 (.0213)	1.0 (.003)	1.0 (.003)	6.0 (.027)	2.67 (.0110)	2.0 (.020)	5.0 (.050)	1.0 (.006)	2.67 (.0253)
	Lumbrineris zonata									1.0 (.015)	2.0 (.010)		1.00 (.0083)				
	Ninoe gemma										1.0 (.018)		0.33 (.0060)			1.0 (.478)	0.33 (.1593)
Nephtyidae	Nephtys ferruginea	6.0 (.062)	2.0 (.017)	4.0 (.020)	4.00 (.0330)	4.0 (.022)	3.0 (.025)	4.0 (.010)	3.67 (.0190)	4.0 (.030)	1.0 (.007)	1.0 (.005)	2.00 (.0140)	5.0 (.043)	3.0 (.029)	2.0 (.015)	3.33 (.0290)
Onuphidae	Onuphis iridescens	4.0 (.206)	1.0 (.002)	1.0 (.122)	2.00 (.1100)	2.0 (.034)	3.0 (.020)		1.67 (.0180)	2.0 (.010)	2.0 (.123)		1.33 (.0443)	1.0 (.058)	2.0 (.173)	1.0 (.014)	1.33 (.0817)
Phyllodocidae	Eteone sp.														1.0 (.002)		0.33 (.0007)
	Eulalia leuicornuta		1.0 (.003)	1.0 (.003)	0.67 (.0020)	1.0 (.003)			0.33 (.0010)								
	Phyllodoce groenlandica						1.0 (.062)		0.33 (.0207)		1.0 (.042)		0.33 (.0140)				
	Phyllodoce williamsi	2.0 (.038)	1.0 (.002)		1.00 (.0133)					1.0 (.008)			0.33 (.0027)	2.0 (.018)			0.67 (.0060)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	2	3	$\bar{x}$	Station 18 1: 1	2	3	$\bar{x}$	Station 19: 1	2	3	$\bar{x}$	Station 20: 1	2	3	$\bar{x}$
Errantia																	
Phyllodocidae	Planktonic phyllodocidae						1.0 (.003)		0.33 (.0010)								
Polynoidae	Unknown sp.							2.0 (.004)	0.67 (.0013)		1.0 (.015)		0.33 (.0050)	1.0 (.015)			0.33 (.0050)
Syllidae	Unknown sp.	1.0 (.004)	1.0 (.001)	1.0 (.001)	1.00 (.0020)		1.0 (.002)	1.0 (.002)	0.67 (.0013)			2.0 (.003)	0.67 (.0010)	2.0 (.008)	2.0 (.017)	1.0 (.004)	1.67 (.0097)

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	Station 17: 2	Station 17: 3	Station 17: $\bar{x}$	Station 18: 1	Station 18: 2	Station 18: 3	Station 18: $\bar{x}$	Station 19: 1	Station 19: 2	Station 19: 3	Station 19: $\bar{x}$	Station 20: 1	Station 20: 2	Station 20: 3	Station 20: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Sedentaria																	
Amphartidae	Amphicteis scaphobranchiata	1.0 (.001)			0.33 (.0003)			1.0 (.002)	0.33 (.0007)	2.0 (.005)			0.67 (.0017)				
Capitellidae	Heteromastus cf. filobranchus	8.0 (.532)	9.0 (.475)	5.0 (.299)	7.33 (.535)	9.0 (.245)	7.0 (.130)	6.0 (.135)	7.33 (.1700)	5.0 (.088)	6.0 (.082)	10.0 (.134)	7.0 (.1013)	10.0 (.123)	5.0 (.078)	5.0 (.035)	6.67 (.0787)
Cirratulidae	Chaetozone setosa	2.0 (.005)	2.0 (.005)	1.0 (.001)	1.67 (.0037)			2.0 (.006)	0.67 (.0020)	3.0 (.004)	2.0 (.004)	4.0 (.005)	3.00 (.0043)	1.0 (.003)			0.33 (.0010)
Disomidae	Trochochaeta multisetosa										2.0 (.004)	1.0 (.003)	1.00 (.0023)				
Flabelligeridae	Unknown sp.	1.0 (.032)		1.0 (.065)	0.67 (.0323)		1.0 (.030)	1.0 (.003)	0.67 (.0110)	1.0 (.012)			0.33 (.0040)	1.0 (.010)			0.33 (.0033)
Maldanidae	Asychis similis			1.0 (.072)	0.33 (.0240)			2.0 (.015)	0.67 (.0050)								
	Euclymene zonalis	12.0 (.100)	12.0 (.192)	3.0 (.012)	9.00 (.1013)	5.0 (.057)	16.0 (.148)	2.0 (.096)	7.67 (.1003)	14.0 (.248)	8.0 (.103)	6.0 (.078)	9.33 (.1430)	9.0 (.072)	9.0 (.190)	3.0 (.026)	7.00 (.0960)
	Maldane glebifex							14.0 (.096)	4.67 (.0320)								
	Praxillella gracilis	1.0 (.432)	2.0 (.611)	3.0 (.030)	2.00 (.3577)			2.0 (.445)	0.67 (.1483)			1.0 (.247)	0.33 (.0823)	4.0 (.842)	2.0 (.338)		2.00 (.3933)
Opheliidae	Ammotrypane aulogaster					1.0 (.063)			0.33 (.0210)			2.0 (.005)	0.67 (.0017)	1.0 (.002)			0.33 (.0007)
Orbiniidae	Haploscoloplos elongata	3.0 (.010)	1.0 (.004)	4.0 (.040)	2.67 (.0180)	1.0 (.008)		2.0 (.010)	1.00 (.0060)								
Oweniidae	Myriochele heeri			1.0 (.002)	0.33 (.0007)			1.0 (.004)	0.33 (.0013)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Oweniidae	Owenia fusiformis			1.0 (.003)	0.33 (.0010)		1.0 (.002)	1.0 (.003)	0.67 (.0017)								
Paraonidae	Aricidea longicornuta		1.0 (.003)		0.33 (.0010)	1.0 (.003)			0.33 (.0010)	1.0 (.005)		1.0 (.001)	0.67 (.0020)	1.0 (.003)	1.0 (.002)		0.67 (.0017)
	Paraonella spinifera	1.0 (.001)			0.33 (.0003)	1.0 (.001)			0.33 (.0003)		1.0 (.001)	3.0 (.002)	1.33 (.0010)		1.0 (.001)		0.33 (.0003)
Spionidae	Polydora uncata		1.0 (.005)		0.33 (.0017)					1.0 (.005)			0.33 (.0017)				
	Laonice cirrata	1.0 (.425)	2.0 (.640)	2.0 (.390)	1.67 (.4850)	2.0 (1.390)	1.0 (.537)	1.0 (.189)	1.33 (.7053)	1.0 (.590)			0.33 (.1967)	1.0 (1.120)	1.0 (.210)	1.0 (.062)	1.00 (.4640)
	Prionospio malmgreni		3.0 (.010)	3.0 (.042)	2.00 (.0173)		2.0 (.003)	3.0 (.008)	1.67 (.0037)	2.0 (.012)	1.0 (.003)	1.0 (.002)	1.33 (.0057)	4.0 (.013)			1.33 (.0043)
Terebellidae	Artacama conifer													2.0 (.008)			0.67 (.0027)
Trichobranchidae																	
	Terebellides stroemi	1.0 (.010)	2.0 (.006)	6.0 (.050)	3.00 (.0220)	1.0 (.032)		2.0 (.004)	1.00 (.0120)	4.0 (.022)	1.0 (.004)	3.0 (.025)	2.67 (.0170)	3.0 (.035)	3.0 (.013)	1.0 (.008)	2.33 (.0187)
	Trichobranchus glacilis									1.0 (.032)			0.33 (.0107)				
	Pista cristata	1.0 (.008)		1.0 (.009)	0.67 (.0057)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.		1.0 (.001)		0.33 (.0003)		1.0 (.003)		0.33 (.0010)								
	Natica clausa	1.0 (.020)			0.33 (.0067)												
Opisthobranchia	Odostomia sp.							1.0 (.004)	0.33 (.0013)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca																	
Pelecypoda (Bivalvia)	Ascila castrensis	1.0 (.312)			0.33 (.1040)						2.0 (.292)	1.0 (.452)	1.00 (.2480)		1.0 (.043)		0.33 (.0143)
	Axinopsida serricata	140.0 (.380)	125.0 (.298)	132.0 (.370)	132.33 (.3493)	72.0 (.162)	115.0 (.284)	133.0 (.272)	106.67 (.2393)	115.0 (.550)	93.0 (.306)	70.0 (.255)	92.67 (.3703)	140.0 (.655)	86.0 (.426)	100.0 (.667)	108.67 (.5827)
	Cardiomya oldroydi	1.0 (.001)	1.0 (.005)	1.0 (.008)	1.00 (.0047)		1.0 (.002)	4.0 (.028)	1.67 (.0100)								
	Compsomyax subdiaphana	1.0 (.114)	2.0 (.197)	1.0 (.101)	1.33 (.1373)		2.0 (2.127)	2.0 (.230)	1.33 (.7857)								
	Lucinoma annulata		2.0 (.316)	1.0 (.132)	1.00 (.1493)	1.0 (.308)	1.0 (.023)	2.0 (.460)	1.33 (.2637)							1.0 (2.289)	0.33 (.7630)
	Macoma alaskansis	9.0 (.688)	10.0 (.562)	3.0 (.033)	7.33 (.4277)	7.0 (.320)	5.0 (.319)	7.0 (.989)	6.33 (.5427)					2.0 (.037)	2.0 (.120)		1.33 (.0523)
	Macoma carlottensis	15.0 (.148)	6.0 (.038)	7.0 (.073)	9.33 (.0863)	10.0 (.112)	16.0 (.164)	18.0 (.100)	14.67 (.1253)	4.0 (.046)	9.0 (.134)	7.0 (.108)	6.67 (.0960)	5.0 (.216)	6.0 (.081)	3.0 (.064)	4.67 (.1203)
	Megacrenella columbiana					1.0 (.010)		1.0 (.002)	0.67 (.0040)								
	Nemocardium sp.		3.0 (.042)	3.0 (.039)	2.00 (.0270)	3.0 (.063)	3.0 (.233)	4.0 (.474)	3.33 (.2567)								
	Nucula tenuis	5.0 (.100)	3.0 (.085)	8.0 (.171)	5.67 (.1187)	7.0 (.171)	10.0 (.104)	9.0 (.090)	8.67 (.1217)		3.0 (.034)	1.0 (.001)	1.33 (.0117)	4.0 (.226)			1.33 (.0753)
	Nuculana minuta	13.0 (.636)	25.0 (.704)	10.0 (.468)	16.0 (.6027)	9.0 (.289)	9.0 (.500)	12.0 (.472)	10.0 (.4203)		3.0 (.063)	2.0 (.101)	1.67 (.0547)	1.0 (.011)	3.0 (.050)	2.0 (.076)	2.00 (.0457)
	Pandora filosa	1.0 (.009)			0.33 (.0030)	2.0 (.050)	1.0 (.015)		1.00 (.0217)						1.0 (.020)	5.0 (.094)	2.00 (.0380)
	Paravalucina tenuisculpits	1.0 (.102)	1.0 (.041)		0.67 (.0477)					1.0 (.332)			0.33 (.1107)	2.0 (.890)		2.0 (1.298)	1.33 (.7293)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

		Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
·TIA																	
	Density	19.0	15.0	15.0	16.34	13.0	18.0	15.0	15.33	15.0	13.0	13.0	13.66	18.0	17.0	9.0	14.66
	Biomass	.606	.315	.459	.4601	.237	.431	.712	.4599	.405	.400	.085	.2966	.941	.744	.602	.7624
	Number of species	7.0	8.0	7.0	7.33	6.0	8.0	6.0	6.67	8.0	9.0	5.0	7.33	8.0	6.0	6.0	7.0
·TARIA	Density	32.0	35.0	32.0	32.99	21.0	28.0	40.0	29.67	35.0	21.0	32.0	29.32	37.0	22.0	10.0	23.00
	Biomass	1.556	1.951	1.015	1.5073	1.799	.850	1.016	1.2216	1.023	.201	.502	.5754	2.231	.832	.131	1.0647
	Number of species	11.0	10.0	13.0	11.33	8.0	6.0	14.0	9.33	11.0	7.0	10.0	9.33	11.0	7.0	4.0	7.33
·ROPODA	Density	1.0	1.0		0.66		1.0	1.0	0.66								
	Biomass	.020	.001		.0070		.003	.004	.0023								
	Number of species	1.0	1.0		0.67		1.0	1.0	0.67								
CYPODA	Density	187.0	178.0	167.0	177.32	112.0	163.0	192.0	155.67	120.0	110.0	81.0	103.67	154.0	99.0	113.0	121.99
	Biomass	2.490	2.288	1.395	2.0577	1.485	3.771	3.117	2.7911	.928	.829	.917	.891	2.035	.740	4.488	2.4209
	Number of species	10.0	10.0	9.0	9.67	9.0	10.0	10.0	9.67	3.0	5.0	5.0	4.33	6.0	6.0	6.0	6.00
·	Density	239.0	229.0	214.0	227.31	146.0	210.0	248.0	201.33	170.0	144.0	126.0	146.65	209.0	138.0	132.0	159.65
	Biomass	4.672	4.555	2.869	4.0321	3.521	5.055	4.849	4.4749	2.356	1.430	1.504	1.7634	5.207	2.316	5.221	4.2480
	Number of species	29.0	29.0	29.0	29.00	23.0	25.0	31.0	26.34	22.0	21.0	20.0	20.99	25.0	19.0	17.0	20.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 September 1976

		Replicate and Mean Density and Biomass*															
		Station 1,5,9,13,17				Station 2,6,10,14,18				Station 3,7,11,15,19				Station 4,8,12,16,20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density																
	Biomass																
	Number of species																
SEDENTARIA	Density																
	Biomass																
	Number of species																
GASTROPODA	Density																
	Biomass																
	Number of species																
PELECYPODA	Density																
	Biomass																
	Number of species																
TOTAL	Density	517.0	945.0	894.0	785.31	376.0	780.0	748.0	634.55	343.0	315.0	355.0	337.63	809.0	899.0	720.0	809.25
	Biomass	10.328	24.055	23.326	19.2358	7.856	14.801	12.467	11.7087	5.054	3.167	4.113	4.1112	18.725	13.688	15.481	15.9646
	Number of species	70.0	107.0	110.0	95.68	77.0	84.0	99.0	86.67	62.0	51.0	66.0	59.68	102.0	85.0	85.0	90.68

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 September 1976

	Station 1				Station 2				Station 3				Station 4			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	198.0	196.0	197.0	197.00	198.0	198.0	198.0	198.00	200.0	198.0	198.0	198.67	216.0	218.0	217.0	217.00
Sample Volume - Litres	7.0	15.0	15.5	12.50	13.0	8.0	7.0	9.33	4.5	9.5	8.0	7.33	12.0	11.5	11.0	11.50
Sample Residue ml/l	92.9	43.3	46.8	61.00	70.0	184.4	128.6	127.67	128.9	68.4	75.0	90.77	185.0	78.3	145.5	136.27
Percent Rock	1.0	5.0	3.0	3.00	11.0	3.0	5.0	6.33	10.0	12.0	5.0	9.00	1.0	2.0	3.0	2.00
Volume Rock ml/l	.9	2.1	1.4	1.50	7.6	6.3	6.4	6.79	12.9	8.2	3.7	8.29	2.0	1.5	4.0	2.57
Percent Wood & Fibers	99.0	95.0	97.0	97.00	89.0	97.0	95.0	93.67	90.0	88.0	95.0	91.00	99.0	98.0	98.0	98.33
Volume Wood and Fibers ml/l	91.0	41.2	45.3	59.47	62.4	178.0	122.2	120.87	116.0	60.2	71.3	82.50	183.0	76.7	141.9	133.93
Percent Wood	85.0	50.0	87.0	74.00	37.0	93.0	80.0	70.00	80.0	78.0	80.0	79.33	77.0	78.0	90.0	81.67
Volume Wood ml/l	78.9	21.7	40.7	47.10	25.7	170.8	102.9	99.80	103.1	53.4	60.0	72.17	142.2	61.0	130.9	111.37
Percent Fibers	14.0	45.0	10.0	23.00	52.0	4.0	15.0	23.67	10.0	10.0	15.0	11.67	22.0	20.0	8.0	16.67
Volume Fibers ml/l	13.0	19.5	4.6	12.39	36.7	7.2	19.3	21.06	12.9	6.8	11.3	10.33	40.8	15.7	11.0	22.50
Surficial Layer Thickness	1/8	1/8	1/8		1/8	1/8	3/16			1/8			1/8	1/8	1/8	
Color Sediment	B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
H_2S Odor			S			S										
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 September 1976

	Station 5				Station 6				Station 7				Station 8			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	198.0	198.0	198.0	198.00	199.0	198.0	198.0	198.33	211.0	212.0	213.0	212.00	21 .0	215.0	216.0	215.67
Sample Volume - Litres	7.0	6.0	7.0	6.67	6.5	7.0	9.0	7.50	7.0	8.5	9.0	8.17	7.5	11.0	10.5	9.67
Sample Residue ml/l	164.3	266.7	157.1	196.03	150.8	128.6	105.6	128.33	92.9	85.3	66.7	81.63	154.7	137.3	139.0	143.67
Percent Rock	11.0	4.0	0	5.00	2.0	5.0	0	2.33	50.0	1.0	30.0	27.00	1.0	0	0	0.33
Volume Rock ml/l	18.2	10.8	0	9.63	2.9	6.4	0	3.12	46.4	.8	20.0	22.42	1.0	0	0	.35
Percent Wood & Fibers	89.0	97.0	100.0	96.0	89.0	95.0	101.0	95.0	50.0	100.0	70.0	73.33	100.0	100.0	100.0	100.0
Volume Wood and Fibers ml/l	146.0	256.0	157.1	186.37	134.0	122.2	105.6	120.60	46.5	85.3	46.7	59.50	154.6	137.3	139.0	149.63
Percent Wood	80.0	88.0	80.0	82.67	84.0	85.0	86.0	85.00	30.0	40.0	60.0	43.33	74.0	87.0	90.0	83.67
Volume Wood ml/l	131.4	233.3	125.7	163.47	126.5	109.3	90.3	108.70	27.9	34.1	40.1	34.03	114.9	120.0	125.1	120.0
Percent Fibers	9.0	9.0	20.0	12.67	5.0	10.0	15.0	10.0	20.0	60.0	10.0	30.00	27.0	13.0	10.0	16.33
Volume Fibers ml/l	14.6	22.7	31.4	20.90	7.5	12.9	15.3	11.90	18.6	51.2	6.67	25.47	39.7	17.3	13.9	23.63
Surficial Layer Thickness	1/8	1/8	1/8		1/8	1/8	1/8		1/8	1/8	1/8		1/8	½	1/8	
Color Sediment	B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 September 1976

	Station 9				Station 10				Station 11				Station 12			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	191.0	193.0	193.0	192.33	194.0	194.0	194.0	194.00	200.0	201.0	205.0	202.00	208.0	210.0	210.0	209.33
Sample Volume - Litres	7.0	5.0	3.5	5.17	7.2	6.0	6.0	6.40	8.8	8.5	8.8	8.70	7.0	6.5	8.0	7.17
Sample Residue ml/l	128.6	220.0	222.9	190.50	69.4	95.8	215.0	126.73	62.5	70.6	69.3	67.47	207.1	138.5	140.6	162.07
Percent Rock	2.0	7.0	5.0	4.67	15.0	0	11.0	8.67	20.0	20.0	0	13.33	1.0	0	9.0	3.33
Volume Rock ml/l	2.5	16.0	11.1	9.89	0.4	0	23.0	11.13	12.5	14.1	0	8.87	1.7	0	12.7	4.83
Percent Wood & Fibers	98.0	93.0	95.0	95.33	85.0	100.0	88.6	91.20	80.0	80.0	100.0	86.67	60.0	99.0	90.0	83.00
Volume Wood and Fibers ml/l	126.0	204.0	212.0	180.67	59.0	95.9	101.2	115.37	50.0	56.4	69.3	58.57	125.8	136.9	127.1	129.93
Percent Wood	93.0	83.0	85.0	87.00	65.0	20.0	82.0	55.67	60.0	75.0	10.0	48.33	30.0	10.0	9.0	16.33
Volume Wood ml/l	119.6	182.0	189.0	163.53	45.1	19.2	177.0	80.43	37.5	52.9	6.9	32.43	62.9	13.9	13.1	29.97
Percent Fibers	5.0	10.0	10.0	8.33	20.0	80.0	6.6	35.53	20.0	5.0	90.0	38.33	30.0	89.0	81.0	66.67
Volume Fibers ml/l	6.4	22.0	23.0	17.14	13.9	76.7	14.2	34.93	12.5	3.5	62.4	26.13	62.9	123.0	114.0	99.97
Surficial Layer Thickness					1/8	½	1/8									
Color Sediment	B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 September 1976

	Station 13				Station 14				Station 15				Station 16			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	182.0	183.0	182.0	182.33	187.0	187.0	184.0	186.00	192.0	191.0	192.0	191.67	200.0	200.0	201.0	200.33
Sample Volume - Litres	10.3	6.3	10.0	6.97	7.0	8.0	10.0	8.33	5.5	7.5	7.0	6.67	13.5	11.0	10.0	11.50
Sample Residue ml/l	154.9	79.2	100.0	111.37	128.6	184.4	155.0	156.00	327.3	260.0	228.6	271.97	74.1	54.5	100.0	76.20
Percent Rock	0	40.0	7.0	15.67	0	2.0	1.0	1.00	4.0	0	0	1.33	0	0	0	0
Volume Rock ml/l	0	31.0	7.2	12.97	0	2.9	.9	1.28	11.8	0	0	3.93	0	0	0	0
Percent Wood & Fibers	98.0	60.0	99.0	85.67	96.0	96.0	98.0	96.67	95.0	100.0	100.0	98.33	100.0	96.0	95.0	97.00
Volume Wood and Fibers ml/l	151.4	47.6	142.0	113.67	123.2	178.1	151.5	150.93	309.9	259.9	228.7	266.17	74.1	52.3	95.0	73.80
Percent Wood	13.0	10.0	5.0	9.33	1.0	15.0	24.0	13.33	22.0	52.0	46.0	40.00	10.0	1.0	20.0	10.00
Volume Wood ml/l	19.4	7.9	48.0	25.10	1.2	28.1	36.5	21.97	70.9	134.9	105.7	103.83	7.4	.5	20.0	9.30
Percent Fibers	85.0	50.0	94.0	76.33	95.0	81.0	74.0	83.33	73.0	48.0	54.0	58.33	90.0	95.0	75.0	86.67
Volume Fibers ml/l	132.0	39.7	94.0	88.57	122.0	150.0	115.0	129.00	239.0	125.0	123.0	162.33	66.7	51.8	75.0	64.50
Surficial Layer Thickness	1/8															
Color Sediment	B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 September 1976

	Station 17				Station 18				Station 19				Station 20			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Depth	178.0	184.0	186.0	182.67	19 .0	193.0	195.0	194.67	170.0	168.0	160.0	166.00	178.0	175.0	181.0	178.00
Sample Volume - Litres	7.0	5.0	5.5	5.83	8.5	6.5	10.0	8.33	12.5	9.0	11.0	10.83	9.0	7.0	8.5	8.17
Sample Residue ml/l	75.0	100.0	63.6	79.53	67.6	61.5	75.0	68.03	56.0	122.2	227.2	135.13	161.1	200.0	82.4	147.83
Percent Rock	88.0	82.0	91.0	87.00	90.1	80.0	90.0	86.70	45.0	61.7	62.4	56.37	20.2	45.6	55.0	40.27
Volume Rock ml/l	66.0	82.0	57.9	68.63	60.9	49.2	67.5	59.20	25.2	75.4	141.8	80.80	32.5	91.1	45.3	56.30
Percent Wood & Fibers	0	0	0	0	4.9	5.9	6.9	5.90	45.0	14.1	42.5	33.87	48.6	50.7	51.9	50.40
Volume Wood and Fibers ml/l	0	0	0	0	3.3	3.6	5.2	4.03	25.2	17.2	96.5	46.30	78.3	101.4	42.8	71.09
Percent Wood	0	0	0	0	0	4.9	2.0	2.30	20.0	10.5	27.7	19.40	15.2	15.4	10.9	13.83
Volume Wood ml/l	0	0	0	0	0	3.0	1.5	1.50	11.2	12.8	63.0	29.00	24.4	30.7	9.0	21.37
Percent Fibers	0	0	0	0	4.9	1.0	4.9	3.60	25.0	3.6	14.7	14.33	33.5	35.4	41.0	36.63
Volume Fibers ml/l	0	0	0	0	3.3	.6	3.7	2.53	14.0	4.4	33.5	17.30	53.9	70.7	33.8	52.80
Surficial Layer Thickness																
Color Sediment	g/g	g/g	g/g		g/g	g/g	g/g		g/g	g/g	g/g		g/g	g/g	g/g	
H_2S Odor																
Associated Debris																
Oil																
Coal																
Seeds																
Metals																
Glass																
Brick																
Blue Clay																

Density of Worm Tubes, Elliott Bay
September 15, 1976

		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF5	1.0	24.0		8.33			2.0	0.67			2.0	0.67	5.0	8.0	3.0	5.33
	MF6	4.0		1.0	1.67	1.0			0.33					3.0			1.00
	MF7											15.0	5.00				
	MR3,7,15						1.0		0.33					11.0			3.67
	MR10		10.0		3.33	13.0		2.0	5.00						8.0		2.67
	MR12		10.0		3.33												
Sand Tubes	SF3	1.0	12.0		4.33												
	SR3	1.0			0.33							2.0	0.67	1.0	2.0		1.00
	SR4	4.0			1.33							1.0	0.33				
	SR7	48.0	1200.0	640.0	629.33	5.0	15.0	7.0	9.00			5.0	1.67	89.0	332.0	71.0	164.00
	SR8			13.0	4.33												
	SR11		40.0	8.0	16.00												
	SR18											2.0	0.67				
	SR20					2.0			0.67								
	SI4					2.0		1.0	1.00	16.0	26.0	22.0	21.33				
	SC1	3.0	4.0	4.0	3.67		1.0		0.33			3.0	1.00	2.0	3.0	3.0	2.67
Mucous Membrane Tubes	MM11			4.0	1.33												
	MM13													1.0			0.33
	MM14		12.0		4.00												
	MM17			2.0	0.67												
	MM19			1.0	0.33		3.0		1.0								

Density of Worm Tubes, Elliott Bay
September 15, 1976

		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1										2.0		0.67				
	MF5		2.0	3.0	1.67			8.0	2.67		2.0		0.67	3.0		1.0	1.33
	MF6		2.0	2.0	1.33									5.0		2.0	2.33
	MR3,7,15			7.0	2.33			3.0	1.00					3.0		2.0	2.67
	MR10		2.0	2.0	1.33	3.0			1.00					4.0		1.0	1.67
Sand Tubes	SF3													6.0			2.00
	SR1						2.0	3.0	1.67						2.0		0.67
	SR3					1.0			0.33		1.0		0.33		2.0	5.0	2.33
	SR4					3.0			1.00						7.0	10.0	5.67
	SR7		454.0	236.0	230.00	10.0	45.0	197.0	84.00		1.0		0.33	114.0	143.0	49.0	102.00
	SR8		12.0	11.0	7.67												
	SR15			15.0	5.00			1.0	0.33								
	SR18	1.0		1.0	0.67						1.0		0.33	2.0			0.67
	SR20						2.0		0.67	2.0	2.0		1.33				
	SF25		5.0		1.67	2.0		6.0	2.67								
	SI4	14.0			3.67		25.0	12.0	12.33	40.0	42.0	95.0	59.00	1.0	3.0	13.0	5.67
	SC1		10.0	10.0	6.67	4.0		2.0	2.00					1.0	1.0		0.67
Mucous Membrane Tubes	MM3		2.0	3.0	1.67	2.0			0.67	3.0	3.0	7.0	4.33				
	MM4			1.0	0.33												
	MM7															1.0	0.33
	MM9			9.0	3.00	3.0			1.00								
	PC2				1.00				0.33								
	PC3															2.0	0.67

Density of Worm Tubes, Elliott Bay
September 15, 1976

		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1							1.0	0.33		1.0	5.0	2.00	2.0			0.67
	MF5							1.0	0.33						1.0		0.33
	MF6	1.0			0.33							2.0	0.67	1.0	2.0	15.0	6.00
	MF7									1.0			0.33	1.0			0.33
	MF9		5.0		1.67		7.0		2.33	1.0		1.0	0.67	1.0	2.0		1.00
	MF10					1.0			0.33	3.0	1.0	2.0	2.00			1.0	0.33
	MR3,7,15															4.0	1.33
	MR10	4.0	1.0		1.67									10.0			3.33
Sand Tubes	SR3		2.0		0.67			2.0	0.67					6.0		2.0	2.67
	SR4							9.0	3.00								
	SR7	35.0	8.0	3.0	15.33			5.0	1.67			9.0	3.00	55.0	44.0	39.0	46.00
	SR18						1.0	8.0	3.00	1.0	2.0	8.0	3.67				
	SR20		1.0		0.33	1.0	5.0	6.0	4.00	1.0	20.0	11.0	10.33	5.0			1.67
	SR24															1.0	0.33
	SI4	8.0	5.0	1.0	4.67	10.0	80.0	9.0	33.00	54.0	55.0	141.0	83.33	40.0	6.0	12.0	19.33
	SC1,2	1.0	4.0	1.0	2.00		1.0	1.0	0.67						1.0	1.0	0.67
Mucous Membrane Tubes	MM3		1.0		0.33			3.0	1.00					3.0		9.0	4.00
	MM4		3.0		1.00												
	MM7							2.0	0.67					1.0			0.33
	MM9		1.0		0.33			1.0	0.33			1.0	0.33				

Density of Worm Tubes, Elliott Bay
September 15, 1976

		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF5			5.0	1.67	10.0			3.33		3.0		1.00	4.0	2.0		2.00
	MF6	6.0		2.0	2.67					4.0	3.0	8.0	5.00	11.0	2.0	1.0	4.67
	MF9					8.0		4.0	4.00	8.0		7.0	5.00	10.0	7.0	4.0	7.00
	MF10										3.0		1.00		1.0		0.33
	MR2			4.0	1.33												
	MR3,7,15		4.0	1.0	1.67	5.0		1.0	2.00	4.0	7.0		3.67	1.0		2.0	1.00
	MR6									5.0	9.0		4.67	5.0	3.0	1.0	3.00
Sand Tubes	SF3	1.0			0.33												
	SF7						2.0		0.67								
	SF9			1.0	0.33												
	SR1	260.0	860.0	37.0	385.67	100.0	38.0	80.0	72.67	12.0			4.00	2.0			0.67
	SR2		2.0		0.67	5.0	2.0		2.33								
	SR3			3.0	1.00		2.0		0.67								
	SR4	8.0	4.0	1.0	4.33	1.0		23.0	8.00					6.0			2.00
	SR5	2.0	2.0	2.0	2.00	4.0			1.33								
	SR7	75.0	100.0	43.0	72.67	208.0	108.0	92.0	160.00	110.0	99.0	80.0	96.33	97.0	84.0	57.0	79.33
	SR8	6.0	12.0	1.0	6.33	48.0	30.0	2.0	26.67		2.0	13.0	5.00	30.0	20.0	5.0	15.00
	SR10	60.0	120.0	14.0	64.00	50.0	40.0	8.0	32.7								
	SC1,2	6.0	16.0	17.0	13.00	24.0	10.0	20.0	18.00	62.0	35.0	16.0	37.67	91.0	21.0	72.0	61.33
	**																
Mucous Membrane Tubes	MM1													1.0			0.33
	MM3	2.0	12.0	3.0	5.67		2.0	2.0	1.33		1.0		0.33		5.0		1.67
	MM7										2.0		0.67				
	MM9			3.0	1.00												
	MM10										1.0		0.33				
	PC1															1.0	0.33
	PC2	1.0		1.0	0.67	2.0		6.0	2.67		3.0		1.00				
	PC3	2.0	4.0		2.00	1.0		3.0	1.33								
Sand Tubes con't**	SR14	2.0			0.67	1.0	1.0		0.67								
	SR15		16.0		5.33												
	SR18							1.0	0.33								
	SR25													2.0	4.0		2.00

Density of Worm Tubes, Elliott Bay
September 15, 1976

		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1											1.0	0.33				
	MF5			1.0	0.33		2.0		0.67								
	MF6	7.0			2.33	5.0	8.0	7.0	6.67	6.0	1.0	8.0	5.00	2.0	3.0	7.0	4.00
	MF9	2.0		1.0	1.00	4.0	10.0	2.0	5.33	1.0		2.0	1.00	6.0	1.0	4.0	3.67
	MF10			2.0	0.67		1.0	1.0	0.67	1.0		1.0	0.67				
	MR1	1.0			0.33												
	MR3,7,15	6.0		1.0	2.33	1.0			0.33						2.0	3.0	1.67
	MR6	3.0			1.00	15.0	1.0	1.0	5.67								
Sand Tubes	SF3	2.0			0.67	1.0		2.0	1.00								
	SF9		1.0		0.33										2.0	1.0	1.00
	SR1	6.0			2.00												
	SR3		1.0	5.0	2.00	5.0	4.0	7.0	5.33			2.0	0.67	8.0		4.0	4.00
	SR4					4.0		1.0	1.67					2.0			0.67
	SR7	56.0	25.0	115.0	65.33	16.0	50.0	50.0	38.67	4.0		4.0	2.67	300.0	370.0	150.0	273.33
	SR8														1.0		0.33
	SR14	2.0			0.67	4.0			1.33								
	SR15					1.0			0.33								
	SR18						1.0		0.33	3.0	1.0		1.67				
	SR20	2.0		1.0	1.00	3.0	1.0	1.0	1.67								
	SR23						1.0		0.33								
	SR25	9.0		3.0	4.00							3.0	1.00		11.0	2.0	4.33
	SI4	12.0	144.0	2.0	52.67			2.0	0.67	6.0	16.0	4.0	8.67				
	SC1	23.0	20.0	34.0	27.67	7.0	6.0	2.0	5.33		4.0	5.0	3.00	1.0	3.0	1.0	1.67
Mucous Membrane Tubes	MM3	8.0		5.0	4.33		9.0		3.00	6.0		2.0	2.67	2.0		3.0	1.67
	MM7		2.0	3.0	1.67		1.0		0.33		1.0	1.0	0.67				
	MM9	2.0			0.67		1.0	1.0	0.67							1.0	0.33
	PC1			1.0	0.33												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass* Station 1: 1	2	3	x̄	Station 2: 1	2	3	x̄	Station 3: 1	2	3	x̄	Station 4: 1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	2.0 (.035)	3.0 (.092)	1.0 (.010)	2.00 (.0457)	3.0 (.170)		1.0 (.022)	1.33 (.0640)	5.0 (.080)	3.0 (.030)		2.67 (.0367)	2.0 (.013)			0.67 (.0043)
Goniadidae	Glycinde armigera													1.0 (.010)	1.0 (.010)	1.0 (.008)	1.00 (.0093)
	Goniada brunnea		2.0 (.010)		0.67 (.0033)									1.0 (.650)			0.33 (.2167)
Lumbrineridae	Lumbrineris zonata	2.0 (.010)	2.0 (.006)	2.0 (.003)	2.00 (.0063)	1.0 (.003)			0.33 (.0010)	3.0 (.033)	2.0 (.008)		1.67 (.0137)	3.0 (.020)	1.0 (.005)	1.0 (.008)	1.67 (.0110)
	Ninoe gemma	1.0 (.006)		1.0 (.020)	0.67 (.0087)												
Nephtyidae	Nephtys ferruginea	5.0 (.048)		2.0 (.008)	2.33 (.0187)	1.0 (.020)			0.33 (.0067)		4.0 (.100)		1.33 (.0333)	1.0 (.003)	1.0 (.005)	1.0 (.003)	1.00 (.0037)
Onuphidae	Onuphis iridescens	1.0 (.125)		4.0 (.272)	1.67 (.1323)					1.0 (.015)			0.33 (.0050)	3.0 (.440)	2.0 (.175)		1.67 (.2050)
Phyllodocidae	Phyllodoce groenlandica									3.0 (.036)			1.0 (.0120)				
	Phyllodoce williamsi	1.0 (.011)	1.0 (.002)		0.67 (.0043)										2.0 (.056)		0.67 (.0187)
Polynoidae	Unknown sp.			1.0 (.002)	0.33 (.0007)									1.0 (.003)		1.0 (.010)	0.67 (.0043)

88

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Capitella capitata							4.0 (.025)	1.33 (.0083)								
	Mediomastus californiensis	11.0 (.512)	25.0 (1.058)	21.0 (.630)	19.00 (.7333)	9.0 (.208)		5.0 (.090)	4.67 (.0993)	4.0 (.048)	2.0 (.018)	6.0 (.120)	4.00 (.0620)	9.0 (.088)	6.0 (.078)	21.0 (.515)	12.00 (.2270)
Chaetopteridae	Chaetozone setosa														1.0 (.008)		0.33 (.0027)
Maldanidae	Euclymene zonalis	41.0 (.362)	23.0 (.262)	6.0 (.040)	23.33 (.2213)	1.0 (.010)		4.0 (.025)	1.67 (.0117)					2.0 (.018)	3.0 (.022)	1.0 (.008)	2.00 (.0160)
	Praxilella gracilis		1.0 (.040)	1.0 (.072)	0.67 (.0373)					2.0 (.270)			0.67 (.0900)	1.0 (.062)		1.0 (.102)	0.67 (.0547)
Opheliidae	Ammotrypane aulogaster						1.0 (.010)		0.33 (.0033)					1.0 (.001)	4.0 (.060)		1.67 (.0170)
Paraonidae	Unknown sp.		4.0 (.007)	2.0 (.003)	2.00 (.0033)						3.0 (.004)		1.00 (.0013)			1.0 (.002)	0.33 (.0007)
Pilargidae	Unknown sp.														1.0 (.005)		0.33 (.0017)
Pectinaridae	Pectinaria californiensis		1.0 (.024)		0.33 (.0080)									1.0 (.020)	2.0 (.095)		1.00 (.0383)
Spionidae	Laonice cirrata	2.0 (.360)	1.0 (.028)		1.00 (.1293)					1.0 (.025)			0.33 (.0083)	3.0 (1.260)	3.0 (.590)		2.00 (.6167)
	Prionospio malmgreni	1.0 (.012)			0.33 (.0040)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1				Station 2				Station 3				Station 4			
		Replicate and Mean Density and Biomass*															
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca Pelecypoda (Bivalvia)	Axinopsida serricata	168.0 (1.431)	182.0 (1.345)	123.0 (.950)	157.67 (1.2420)	44.0 (.268)	1.0 (.005)	15.0 (.096)	20.0 (.1230)	58.0 (.353)	31.0 (.212)	45.0 (.225)	44.67 (.2633)	101.0 (.847)	106.0 (.836)	10.0 (.079)	72.33 (.5873)
	Compsomyax subdiaphana	1.0 (.052)	1.0 (2.547)	1.0 (.182)	1.0 (.9270)					1.0 (3.315)	1.0 (.633)		0.67 (1.3160)				
	Lucinoma annulata		1.0 (.183)		0.33 (.0610)												
	Macoma alaskansis			2.0 (.482)	0.67 (.1607)		1.0 (.001)		0.33 (.0003)	5.0 (1.408)	3.0 (.452)	1.0 (.022)	3.0 (.6273)	1.0 (.053)			0.33 (.0177)
	Macoma carlottensis	31.0 (1.894)	13.0 (.512)	17.0 (.726)	20.33 (1.0440)	5.0 (.063)		4.0 (.046)	3.0 (.0363)	13.0 (.749)	5.0 (.113)	15.0 (.499)	11.0 (.4537)	25.0 (.995)	22.0 (.944)	14.0 (.596)	20.33 (.8450)
	Macoma inquinata	3.0 (.551)	6.0 (.555)		3.00 (.3687)					1.0 (.079)	3.0 (.504)	1.0 (.050)	1.67 (.2110)	1.0 (.060)		1.0 (.136)	0.67 (.0653)
	Nucula tenuis		1.0 (.028)		0.33 (.0093)	1.0 (.043)		3.0 (.065)	1.33 (.0360)	2.0 (.039)		1.0 (.026)	1.0 (.0217)	1.0 (.034)	1.0 (.004)		0.67 (.0127)
	Nuculana minuta	1.0 (.032)	1.0 (.045)	2.0 (.008)	1.33 (.0283)	1.0 (.134)		1.0 (.011)	0.67 (.0483)	2.0 (.138)	6.0 (.151)	1.0 (.009)	3.0 (.0993)				
	Pandora filosa			1.0 (.076)	0.33 (.0253)												
	Yoldia sp.													1.0 (.715)			0.33 (.2383)

70

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Gastropoda Prosobranchia	Barleeia sp.															1.0 (.001)	0.33 (.0003)
	Oenopota sp.									1.0 (.043)			0.33 (.0143)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	12.0	8.0	11.0	10.34	5.0		1.0	2.0	12.0	9.0		7.00	12.0	7.0	4.0	7.68
	Biomass	.235	.110	.315	.2200	.193		.022	.0717	.164	.138		.1007	1.139	.251	.029	.4730
	Number of species	6.0	4.0	6.0	5.33	3.0		1.0	1.33	4.0	3.0		2.33	7.0	5.0	4.0	5.33
SEDENTARIA	Density	55.0	55.0	30.0	46.30	10.0	1.0	13.0	8.0	7.0	5.0	6.0	6.00	17.0	20.0	24.0	20.33
	Biomass	1.246	1.419	.745	1.1365	.218	.010	.140	.1226	.343	.022	.120	.1616	1.429	.748	.627	.9347
	Number of species	4.0	6.0	4.0	4.67	2.0	1.0	3.0	2.00	3.0	2.0	1.0	2.00	5.0	5.0	4.0	4.67
GASTROPODA	Density									1.0			0.33			1.0	0.33
	Biomass									.043			.0143			.001	.0003
	Number of species									1.0			0.33			1.0	0.33
PELECYPODA	Density	204.0	205.0	146.0	184.99	51.0	2.0	23.0	25.33	82.0	49.0	64.0	65.01	130.0	129.0	25.0	94.66
	Biomass	3.960	5.215	2.424	3.8663	.508	.006	.218	.2438	6.081	2.065	.831	2.9923	2.704	1.784	.811	1.7663
	Number of species	5.0	7.0	6.0	6.00	4.0	2.0	4.0	3.33	7.0	6.0	6.0	6.33	6.0	3.0	3.0	4.00
TOTAL	Density	271.0	267.0	187.0	241.63	66.0	3.0	37.0	35.33	102.0	63.0	70.0	78.34	159.0	156.0	54.0	123.00
	Biomass	5.441	6.744	3.484	5.2228	.919	.016	.380	.4381	6.631	2.225	.951	3.2689	5.272	2.783	1.468	3.1743
	Number of species	15.0	17.0	16.0	16.00	9.0	3.0	8.0	6.66	15.0	11.0	7.0	10.99	18.0	13.0	12.0	14.33

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass* Station 5: 1	Station 5: 2	Station 5: 3	Station 5: x̄	Station 6: 1	Station 6: 2	Station 6: 3	Station 6: x̄	Station 7: 1	Station 7: 2	Station 7: 3	Station 7: x̄	Station 8: 1	Station 8: 2	Station 8: 3	Station 8: x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*		3.0 (.085)	1.0 (.062)	1.33 (.0490)	1.0 (.005)			0.33 (.0017)					1.0 (.073)	2.0 (.018)	2.0 (.052)	1.67 (.0477)
Goniadidae	*Glycinde armigera*	1.0 (.028)			0.33 (.0093)												
Lumbrineridae	*Lumbrineris zonata*		2.0 (.023)	1.0 (.003)	1.00 (.0087)	1.0 (.008)			0.33 (.0027)					4.0 (.022)	4.0 (.031)		2.67 (.0177)
Nephtyidae	*Nephtys ferruginea*	1.0 (.010)	4.0 (.025)	2.0 (.037)	2.33 (.0240)	1.0 (.010)	2.0 (.030)		1.00 (.013)			1.0 (.015)	0.33 (.0050)		3.0 (.010)	3.0 (.018)	2.00 (.0093)
Onuphidae	*Onuphis iridescens*		1.0 (.041)		0.33 (.0137)									1.0 (.345)		1.0 (.152)	0.67 (.1657)
Phyllodocidae	*Phyllodoce williamsi*		1.0 (.004)	2.0 (.006)	1.00 (.0033)						1.0 (.007)		0.33 (.0023)	1.0 (.003)			0.33 (.0010)
Polynoidae	Unknown sp.	1.0 (.003)			0.33 (.0010)						1.0 (.005)		0.33 (.0017)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Arenicolidae	Abarenicola pacifica											1.0 (.655)	0.33 (.2183)				
Capitellidae	Mediomastus californiensis	3.0 (.038)	17.0 (.152)	6.0 (.165)	8.67 (.1183)	10.0 (.192)	1.0 (.003)	5.0 (.255)	5.33 (.1500)	1.0 (.006)	1.0 (.001)		0.67 (.0023)	13.0 (.442)	12.0 (.308)	1.0 (.022)	8.67 (.2573)
Chaetopteridae	Chaetozone setosa		1.0 (.003)		0.33 (.0010)												
Maldanidae	Euclymene zonalis	2.0 (.010)	19.0 (.133)	4.0 (.035)	8.33 (.0593)	7.0 (.080)	2.0 (.017)		3.00 (.0323)	1.0 (.008)			0.33 (.0027)	4.0 (.042)	2.0 (.013)	1.0 (.006)	2.33 (.0203)
	Praxilella gracilis			1.0 (.020)	0.33 (.0067)												
Opheliidae	Ammotrypane aulogaster	3.0 (.015)		1.0 (.001)	1.33 (.0053)	2.0 (.004)			0.67 (.0013)		3.0 (.005)		1.00 (.0017)	6.0 (.003)	2.0 (.002)		2.67 (.0017)
Oweniidae	Owenia fusiformis		1.0 (.001)		0.33 (.0003)												
Paraonidae	Unknown sp.		1.0 (.001)	2.0 (.003)	1.00 (.0013)	2.0 (.004)	1.0 (.004)		1.00 (.0027)								
Pectinariidae	Pectinaria californiensis		1.0 (.015)		0.33 (.0050)		1.0 (.007)		0.33 (.0023)								
Spionidae	Laonice cirrata			1.0 (.061)	0.33 (.0203)	1.0 (.202)			0.33 (.0673)						2.0 (.183)	1.0 (.015)	1.00 (.0660)
	Prionospio malmgreni			1.0 (.006)	0.33 (.0020)										1.0 (.003)		0.33 (.0010)
	Polydora cardalia										4.0 (.015)		1.33 (.0050)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca																	
Pelecypoda (Bivalvia)	Axinopsida serricata	7.0 (.032)	211.0 (.939)	50.0 (.349)	89.33 (.4400)	64.0 (.372)	40.0 (.302)	2.0 (.010)	35.33 (.2280)	2.0 (.010)			0.67 (.0033)		39.0 (.318)	1.0 (.005)	13.33 (.1077)
	Compsomyax subdiaphana						1.0 (.624)		0.33 (.2080)								
	Macoma alaskansis			1.0 (.388)	0.33 (.1293)	1.0 (.015)		1.0 (.204)	0.67 (.0730)						1.0 (.081)		0.33 (.0270)
	Macoma carlottensis	5.0 (.205)	15.0 (.697)	11.0 (.284)	10.33 (.3953)	3.0 (.060)	5.0 (.119)	1.0 (.013)	3.0 (.0640)		3.0 (.048)	1.0 (.056)	1.33 (.0347)	4.0 (.042)	5.0 (.082)	2.0 (.046)	3.67 (.0567)
	Macoma inquinata		2.0 (.230)	2.0 (.155)	1.33 (.1263)		2.0 (.059)		0.67 (.0197)						2.0 (.064)		0.67 (.0213)
	Nucula tenuis		1.0 (.006)		0.33 (.0020)												
	Paravalucina tenuisculptis			1.0 (.073)	0.33 (.0243)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Gastropoda Prosobranchia	Polinices sp.					1.0 (1.141)			0.33 (.3803)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

		Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	3.0	11.0	6.0	6.65	2.0	2.0		1.33		2.0	1.0	1.99	7.0	9.0	6.0	7.34
	Biomass	.041	.178	.108	.1090	.023	.030		.0177		.012	.015	.0090	.443	.059	.222	.2414
	Number of species	3.0	5.0	4.0	4.0	3.0	1.0		1.33		2.0	1.0	1.0	4.0	3.0	3.0	3.33
SEDENTARIA	Density	8.0	40.0	16.0	21.28	22.0	5.0	5.0	10.66	2.0	5.0	1.0	2.67	23.0	19.0	3.0	14.97
	Biomass	.063	.305	.291	.2195	.482	.031	.256	.2559	.014	.016	.655	.2300	.487	.509	.043	.3463
	Number of species	3.0	6.0	7.0	5.33	5.0	4.0	1.0	3.33	2.0	3.0	1.0	2.0	3.0	6.0	3.0	4.00
GASTROPODA	Density					1.0			0.33								
	Biomass					1.141			.3803								
	Number of species					1.0			0.33								
PELECYPODA	Density	12.0	229.0	65.0	101.95	68.0	48.0	4.0	40.0	2.0	3.0	1.0	2.0	4.0	47.0	3.0	18.00
	Biomass	.237	1.872	1.249	1.1192	.447	1.104	.227	.5927	.010	.048	.056	.0380	.042	.545	.051	.2127
	Number of species	2.0	4.0	5.0	3.67	3.0	4.0	3.0	3.33	1.0	1.0	1.0	1.00	1.0	4.0	2.0	2.33
TOTAL	Density	23.0	280.0	87.0	129.88	93.0	55.0	9.0	52.29	4.0	10.0	3.0	5.66	34.0	75.0	12.0	40.31
	Biomass	.341	2.355	1.648	1.4477	2.085	1.165	.483	1.2466	.024	.076	.726	.2770	.972	1.113	.3160	.8004
	Number of species	8.0	15.0	16.0	13.0	12.0	9.0	4.0	8.32	3.0	6.0	3.0	4.0	8.0	13.0	8.0	9.66

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 9: 1	Station 9: 2	Station 9: 3	Station 9: x̄	Station 10: 1	Station 10: 2	Station 10: 3	Station 10: x̄	Station 11: 1	Station 11: 2	Station 11: 3	Station 11: x̄	Station 12: 1	Station 12: 2	Station 12: 3	Station 12: x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	2.0 (.070)		1.0 (.028)	1.00 (.0327)										1.0 (.042)		0.33 (.0140)
Lumbrineridae	Lumbrineris zonata			1.0 (.003)	0.33 (.0010)	1.0 (.007)			0.33 (.0023)					2.0 (.040)	2.0 (.013)	1.0 (.001)	1.67 (.0180)
	Ninoe gemma			1.0 (.002)	0.33 (.0007)									1.0 (.021)			0.33 (.0070)
Nephtyidae	Nephtys ferruginea	1.0 (.011)			0.33 (.0037)									4.0 (.022)	2.0 (.032)	1.0 (.025)	2.33 (.0263)
Onuphidae	Onuphis iridescens													1.0 (.253)			0.33 (.0843)
Phyllodocidae	Eteone sp.													1.0 (.032)			0.33 (.0107)
	Phyllodoce williamsi						1.0 (.002)		0.33 (.0007)	1.0 (.002)			0.33 (.0007)		1.0 (.002)		0.33 (.0007)
Polynoidae	Unknown sp.	1.0 (.008)			0.33 (.0027)												

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Ampharete goesi															1.0 (.001)	0.33 (.0003)
Capitellidae	Mediomastus californiensis	1.0 (.036)	2.0 (.020)	7.0 (.050)	3.33 (.0353)		1.0 (.008)		0.33 (.0027)	1.0 (.003)			0.33 (.0010)	10.0 (.250)	8.0 (.245)	3.0 (.042)	7.00 (.1790)
Maldanidae	Euclymene zonalis													3.0 (.035)		2.0 (.043)	1.67 (.0260)
Opheliidae	Ammotrypane aulogaster		1.0 (.002)		0.33 (.0007)					3.0 (.003)			1.00 (.0010)	3.0 (.001)	3.0 (.004)	1.0 (.001)	2.33 (.0020)
Paraonidae	Aricidea longicornuta	1.0 (.001)		1.0 (.003)	0.67 (.0013)												
Pectinariidae	Pectinaria californiensis													1.0 (.115)			0.33 (.0383)
Spionidae	Prionospio malmgreni													3.0 (.005)	1.0 (.018)	1.0 (.002)	1.67 (.0083)
	Polydora sp.									13.0 (.028)	4.0 (.012)	12.0 (.051)	9.67 (.0303)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	*Oenopota* sp.														1.0 (.047)	1.0 (.020)	0.67 (.0223)

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Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass* Station 9: 1	Station 9: 2	Station 9: 3	Station 9: $\bar{x}$	Station 10: 1	Station 10: 2	Station 10: 3	Station 10: $\bar{x}$	Station 11: 1	Station 11: 2	Station 11: 3	Station 11: $\bar{x}$	Station 12: 1	Station 12: 2	Station 12: 3	Station 12: $\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Axinopsida serricata	2.0 (.016)	3.0 (.021)		1.67 (.0123)									32.0 (.241)	3.0 (.015)	30.0 (.204)	21.67 (.1533)
	Macoma alaskansis		1.0 (.229)		0.33 (.0763)												
	Macoma carlottensis		1.0 (.007)	3.0 (.122)	1.33 (.0430)	2.0 (.036)	2.0 (.023)	2.0 (.060)	2.0 (.0397)		2.0 (.006)	3.0 (.028)	1.67 (.0113)	10.0 (.498)	2.0 (.026)	17.0 (.575)	9.67 (.3663)
	Macoma inquinata			4.0 (.288)	1.33 (.0960)												
	Nucula tenuis															1.0 (.003)	0.33 (.0010)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

		Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	4.0		3.0	2.32	1.0	1.0		0.66	1.0			0.33	9.0	6.0	2.0	5.65
	Biomass	.089		.033	.0408	.007	.002		.0030	.002			.0007	.368	.089	.026	.1610
	Number of species	3.0		3.0	2.0	1.0	1.0		0.67	1.0			0.33	5.0	4.0	2.0	3.67
SEDENTARIA	Density	2.0	3.0	8.0	4.33		1.0		0.33	17.0	4.0	12.0	11.0	20.0	12.0	8.0	13.33
	Biomass	.037	.022	.053	.0373		.008		.0027	.034	.012	.051	.0323	.046	.267	.088	.2536
	Number of species	2.0	2.0	2.0	2.00		1.0		0.33	3.0	1.0	1.0	1.67	5.0	3.0	5.0	4.33
GASTROPODA	Density														1.0	1.0	0.67
	Biomass														.047	.020	.022
	Number of species														1.0	1.0	0.67
PELECYPODA	Density	2.0	5.0	7.0	4.66	2.0	2.0	2.0	2.00		2.0	3.0	1.67	42.0	5.0	48.0	31.67
	Biomass	.016	.257	.410	.2276	.036	.023	.060	.0397		.006	.028	.0113	.739	.041	.782	.5206
	Number of species	1.0	3.0	2.0	2.0	1.0	1.0	1.0	1.0		1.0	1.0	0.67	2.0	2.0	3.0	2.33
TOTAL	Density	8.0	8.0	18.0	11.31	3.0	4.0	2.0	2.99	18.0	6.0	15.0	13.00	71.0	24.0	59.0	51.32
	Biomass	.142	.279	.496	.3057	.043	.033	.060	.0454	.036	.018	.079	.0443	1.513	.444	.916	.9572
	Number of species	6.0	5.0	7.0	6.00	2.0	3.0	1.0	2.00	4.0	2.0	2.0	2.67	12.0	10.0	11.0	11.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	3.0 (.163)	3.0 (.015)	4.0 (.207)	3.33 (.1283)	5.0 (.110)	4.0 (.116)		3.00 (.0753)	1.0 (.089)			0.33 (.0297)	2.0 (.019)		2.0 (.082)	1.33 (.0337)
Goniadidae	Goniada brunnea							1.0 (.007)	0.33 (.0023)					1.0 (.010)			0.33 (.0033)
Lumbrineridae	Lumbrineris luti		1.0 (.010)		0.33 (.0033)												
	Lumbrineris zonata	6.0 (.100)	4.0 (.048)	1.0 (.007)	3.67 (.0517)	3.0 (.036)	4.0 (.076)	2.0 (.022)	3.00 (.0447)					2.0 (.010)		4.0 (.050)	2.00 (.0200)
Nephtyidae	Nephtys ferruginea	2.0 (.009)	6.0 (.042)	4.0 (.034)	4.00 (.0283)	3.0 (.060)	3.0 (.056)	3.0 (.032)	3.00 (.0493)			1.0 (.006)	0.33 (.0020)	1.0 (.007)	3.0 (.032)	2.0 (.030)	2.00 (.0230)
Neridae	Nereis procera									1.0 (.012)			0.33 (.0040)				
Onuphidae	Onuphis iridescens	1.0 (.028)			0.33 (.0093)									1.0 (.188)		1.0 (.062)	0.67 (.0833)
Phyllodocidae	Eteone sp.									1.0 (.008)			0.33 (.0027)				
	Phyllodoce williamsi	2.0 (.006)	1.0 (.002)		1.00 (.0027)	1.0 (.002)	1.0 (.160)	1.0 (.022)	1.00 (.0613)			2.0 (.022)	0.67 (.0073)	2.0 (.065)			0.67 (.0217)
Polynoidae	Unknown sp.	1.0 (.001)			0.33 (.0003)		2.0 (.003)		0.67 (.0010)								
Sigalionidae	Pholoe minuta														1.0 (.001)		0.33 (.0003)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum Class Subclass Order Family	Scientific Name	Station 13 1	2	3	$\bar{x}$	Station 14 1	2	3	$\bar{x}$	Station 15 1	2	3	$\bar{x}$	Station 16 1	2	3	$\bar{x}$
		Replicate and Mean Density and Biomass*															
Errantia																	
Sphaeroidoridae	Unknown sp.	1.0 (.001)			0.33 (.0003)												
Syllidae	*Syllis harti*		1.0 (.006)		0.33 (.0020)	2.0 (.010)	1.0 (.002)		1.00 (.0040)								
	Unknown Syllids	1.0 (.002)			0.33 (.0007)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Ampharete goesi		1.0 (.002)	1.0 (.002)	0.67 (.0013)	2.0 (.002)			0.67 (.0007)	1.0 (.001)		1.0 (.002)	0.67 (.0010)		1.0 (.001)		0.33 (.0007)
Capitellidae	Mediomastus californiensis	5.0 (.052)	12.0 (.540)	1.0 (.056)	6.00 (.2160)	6.0 (.343)	5.0 (.048)	3.0 (.047)	4.67 (.1460)	5.0 (.093)	5.0 (.045)	6.0 (.205)	5.33 (.1143)	9.0 (.168)	3.0 (.054)	8.0 (.202)	6.67 (.1413)
Cirratulidae	Chaetozone setosa	3.0 (.019)	2.0 (.003)		1.67 (.0073)		3.0 (.024)		1.00 (.0080)						1.0 (.005)	1.0 (.001)	0.67 (.0020)
Disomidae	Unknown sp.									1.0 (.001)			0.33 (.0003)				
Maldanidae	Euclymene zonalis	1.0 (.001)	1.0 (.010)		0.67 (.0037)	1.0 (.003)	4.0 (.030)	2.0 (.020)	2.33 (.0177)					5.0 (.040)	6.0 (.058)	6.0 (.048)	5.67 (.0487)
	Praxilella gracilis	1.0 (.068)			0.33 (.0227)	1.0 (.901)	1.0 (.144)		0.67 (.3483)	1.0 (.160)			0.33 (.0533)	1.0 (.495)		1.0 (.024)	0.67 (.1730)
Opheliidae	Ammotrypane aulogaster	8.0 (.007)	5.0 (.010)	2.0 (.060)	5.00 (.0257)	10.0 (.010)	2.0 (.010)	2.0 (.003)	4.67 (.0077)	8.0 (.083)	4.0 (.003)	1.0 (.001)	4.33 (.0290)	2.0 (.005)	2.0 (.062)	6.0 (.007)	3.33 (.0247)
Oweniidae	Owenia fusiformis		1.0 (.010)		0.33 (.0033)												
Paraonidae	Aricidea longicornuta						3.0 (.020)		1.00 (.0067)								
Pectinariidae	Pectinaria californiensis	5.0 (.168)		2.0 (.055)	2.33 (.0743)	3.0 (.122)	1.0 (.020)		1.33 (.0473)							1.0 (.018)	0.33 (.0060)
Sabellidae	Unknown sp.					1.0 (.263)			0.33 (.0877)								
Spionidae	Laonice cirrata	2.0 (.245)	2.0 (.482)	1.0 (.157)	1.67 (.2947)			1.0 (.051)	0.33 (.0170)					2.0 (1.420)		2.0 (1.026)	1.33 (.8153)
	Polydora sp.						1.0 (.005)		0.33 (.0017)								

Replicate and Mean Density and Biomass*

Table

<u>Density and Biomass of Benthic Assemblages, Elliott Bay</u>

<u>Sampled 15 June 1976</u>

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Spionidae	<u>Prionospio malmgreni</u>						2.0 (.002)	1.0 (.005)	1.00 (.0023)	1.0 (.001)			0.33 (.0003)				
Terebellidae	Unknown sp.															1.0 (.004)	0.33 (.0013)
Trichobranchidae	<u>Trichobranchus glacilis</u>						1.0 (.028)		0.33 (.0093)								

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13: 1	Station 13: 2	Station 13: 3	Station 13: $\bar{x}$	Station 14: 1	Station 14: 2	Station 14: 3	Station 14: $\bar{x}$	Station 15: 1	Station 15: 2	Station 15: 3	Station 15: $\bar{x}$	Station 16: 1	Station 16: 2	Station 16: 3	Station 16: $\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.		1.0 (.003)		0.33 (.0010)												
	Mitrella gouldi	1.0 (.065)	1.0 (.005)		0.67 (.0233)												

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13: 1	Station 13: 2	Station 13: 3	Station 13: x̄	Station 14: 1	Station 14: 2	Station 14: 3	Station 14: x̄	Station 15: 1	Station 15: 2	Station 15: 3	Station 15: x̄	Station 16: 1	Station 16: 2	Station 16: 3	Station 16: x̄
		Replicate and Mean Density and Biomass*															
Mollusca Pelecypoda (Bivalvia)	Axinopsida serricata	251.0 (1.627)	253.0 (1.367)	35.0 (.229)	179.67 (1.0743)	175.0 (1.196)	133.0 (.791)	107.0 (.649)	138.33 (.8787)	64.0 (.423)	6.0 (.030)	67.0 (.440)	45.67 (.2977)	183.0 (1.080)	230.0 (1.559)	99.0 (.702)	170.67 (1.1137)
	Cardiomya oldroydi	2.0 (.044)		1.0 (.055)	1.0 (.0330)												
	Compsomyax subdiaphana		3.0 (1.531)		1.0 (.5103)									1.0 (5.027)			0.33 (1.6757)
	Lucinoma annulata	1.0 (.027)			0.33 (.0090)	2.0 (.490)			0.67 (.1633)								
	Lysonia pugettensis			1.0 (.012)	0.33 (.0040)												
	Macoma alaskansis	1.0 (.241)	1.0 (.203)		0.67 (.1480)	1.0 (.440)	1.0 (.277)	4.0 (.210)	2.0 (.3090)	1.0 (.467)		1.0 (.603)	0.67 (.3567)				
	Macoma carlottensis	63.0 (2.635)	45.0 (1.914)	9.0 (.343)	39.0 (1.6307)	21.0 (.651)	28.0 (.938)	15.0 (.416)	21.33 (.6683)	12.0 (.331)		6.0 (.161)	6.0 (.1640)	38.0 (1.858)	33.0 (1.488)	24.0 (1.342)	31.67 (1.5627)
	Macoma nasuta		1.0 (.129)		0.33 (.0430)												
	Macoma inquinata		1.0 (.130)		0.33 (.0433)	5.0 (.585)	3.0 (.203)		2.67 (.2627)						2.0 (.244)	1.0 (.150)	1.0 (.1313)
	Megacrenella columbiana		1.0 (.018)		0.33 (.0060)												
	Nucula tenuis	2.0 (.019)	2.0 (.033)		1.33 (.0173)	1.0 (.001)		1.0 (.015)	0.67 (.0053)	2.0 (.071)		2.0 (.071)	1.33 (.0473)	5.0 (.073)	2.0 (.108)	4.0 (.105)	3.67 (.0953)
	Nuculana minuta	8.0 (.105)	4.0 (.072)	5.0 (.111)	5.67 (.0960)	11.0 (.319)	2.0 (.056)	2.0 (.046)	5.0 (.1403)	2.0 (.055)		1.0 (.004)	1.0 (.0197)	2.0 (.016)		1.0 (.035)	1.0 (.0170)
	Pandora filosa	1.0 (.036)			0.33 (.0120)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda	Paravalucina tenuisculptis					1.0 (.034)			0.33 (.0113)					1.0 (.050)			0.33 (.0167)
	Yoldia sp.										1.0 (.416)		0.33 (.1387)				

109

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

		Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ERRANTIA	Density	16.0	17.0	9.0	13.98	14.0	15.0	7.0	12.00	3.0		3.0	1.99	9.0	4.0	9.0	7.33
	Biomass	.308	.125	.248	.2269	.218	.413	.0830	.2379	.109		.028	.0457	.299	.033	.224	.1853
	Number of species	7.0	7.0	3.0	5.67	5.0	6.0	4.0	5.00	3.0		2.0	1.67	6.0	2.0	4.0	4.00
SEDENTARIA	Density	25.0	24.0	7.0	18.67	24.0	23.0	9.0	18.66	17.0	9.0	8.0	11.32	19.0	13.0	26.0	19.33
	Biomass	.560	1.057	.330	.649	1.644	.331	.1343	.7004	.339	.048	.208	.1986	2.128	.180	1.33	1.2127
	Number of species	7.0	7.0	5.0	6.33	7.0	10.0	5.0	7.33	6.0	2.0	3.0	3.67	5.0	5.0	8.0	6.00
GASTROPODA	Density	1.0	2.0		1.00												
	Biomass	.065	.008		.0243												
	Number of species	1.0	2.0		1.00												
PELECYPODA	Density	329.0	311.0	51.0	230.32	217.0	167.0	129.0	171.0	81.0	7.0	77.0	55.0	230.0	267.0	129.0	208.67
	Biomass	4.734	5.397	.750	3.6269	3.716	2.265	1.336	2.4389	1.347	.446	1.279	1.0241	8.104	3.399	2.334	4.6124
	Number of species	8.0	9.0	5.0	7.33	8.0	5.0	5.0	6.00	5.0	2.0	5.0	4.00	6.0	4.0	5.0	5.00
TOTAL	Density	371.0	354.0	67.0	263.97	255.0	205.0	145.0	201.66	101.0	16.0	88.0	68.31	258.0	284.0	164.0	235.33
	Biomass	5.667	6.587	1.328	4.5188	5.578	3.009	1.553	3.3772	1.795	.494	1.515	1.2684	10.531	3.612	3.888	6.0107
	Number of species	23.0	25.0	13.0	20.33	20.0	21.0	14.0	18.33	14.0	4.0	10.0	9.34	17.00	11.0	17.0	15.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	1.0 (.006)	2.0 (.085)	1.0 (.018)	1.33 (.0363)	2.0 (.091)	5.0 (.156)	5.0 (.152)	4.00 (.1330)	2.0 (.018)	3.0 (.048)	8.0 (.263)	4.33 (.1097)	3.0 (.035)	3.0 (.042)	4.0 (.068)	3.33 (.0483)
Goniadidae	Goniada brunnea	1.0 (.010)			0.33 (.0033)	2.0 (.012)		1.0 (.010)	1.00 (.0073)						4.0 (.108)		1.33 (.0360)
Lumbrineridae	Lumbrineris bicirrata													2.0 (.021)			0.67 (.0070)
	Lumbrineris zonata	3.0 (.007)	6.0 (.058)	3.0 (.012)	4.00 (.0257)	1.0 (.014)	2.0 (.023)	7.0 (.024)	3.33 (.0203)	2.0 (.014)	3.0 (.028)	7.0 (.052)	4.00 (.0313)		3.0 (.022)	3.0 (.015)	2.00 (.0123)
	Ninoe gemma					1.0 (.098)			0.33 (.0327)			1.0 (.030)	0.33 (.0100)	1.0 (.021)			0.33 (.0070)
Nephtyidae	Nephtys ferruginea	3.0 (.012)	7.0 (.015)	4.0 (.022)	4.67 (.0163)	3.0 (.010)	2.0 (.003)	7.0 (.019)	4.00 (.0107)	4.0 (.004)	5.0 (.040)	1.0 (.002)	3.33 (.0153)	1.0 (.002)	2.0 (.022)	4.0 (.029)	2.33 (.0177)
Onuphidae	Onuphis iridescens		2.0 (.048)	2.0 (.105)	1.33 (.0510)	1.0 (.182)	2.0 (.075)	1.0 (.032)	1.33 (.0963)	1.0 (.003)	2.0 (.130)	4.0 (.018)	2.33 (.0503)		3.0 (.333)	2.0 (.046)	1.67 (.1263)
Phyllodocidae	Phyllodoce williamsi							3.0 (.027)	1.00 (.0090)			1.0 (.008)	0.33 (.0027)		1.0 (.004)	1.0 (.001)	0.67 (.0017)
	Planktonic phyllodocidae					1.0 (.010)	1.0 (.003)		0.67 (.0043)								
Polynoidae	Unknown sp.		1.0 (.004)	1.0 (.001)	0.67 (.0017)					1.0 (.007)		1.0 (.003)	0.67 (.0033)				
Sphaerodoridae	Unknown sp.		1.0 (.001)		0.33 (.0003)												
Syllidae	Syllis harti	2.0 (.010)			0.67 (.0033)							1.0 (.012)	0.33 (.0040)				

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Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Ampharete goesi											1.0 (.007)	0.33 (.0023)				
Capitellidae	Heteromastus cf. filobranchus	9.0 (.323)	33.0 (1.042)	17.0 (.292)	19.67 (.5523)	5.0 (.104)	16.0 (.452)	6.0 (.357)	9.00 (.3043)	15.0 (.810)	13.0 (.178)	14.0 (.160)	14.00 (.3827)	10.0 (.120)	12.0 (.291)	12.0 (.190)	11.33 (.2003)
Cirratulidae	Chaetozone setosa					2.0 (.011)		3.0 (.005)	1.67 (.0053)			3.0 (.002)	1.00 (.0007)				
Maldanidae	Asychis similis					1.0 (.042)	1.0 (.020)		0.67 (.0207)								
	Euclymene zonalis	5.0 (.033)	4.0 (.036)	3.0 (.010)	4.00 (.0280)	7.0 (.068)	10.0 (.068)	22.0 (.118)	13.00 (.0847)	12.0 (.082)	7.0 (.079)	7.0 (.040)	8.67 (.0670)	3.0 (.085)	8.0 (.052)	5.0 (.070)	5.33 (.0690)
	Praxillella gracilis	1.0 (.040)	1.0 (.043)	1.0 (.010)	1.00 (.0310)	1.0 (.212)		1.0 (.830)	0.67 (.3473)	2.0 (.462)	2.0 (.100)	4.0 (.210)	2.67 (.2573)	1.0 (.020)	3.0 (.582)	3.0 (.794)	2.33 (.4653)
Opheliidae	Ammotrypane aulogaster							1.0 (.002)	0.33 (.0007)								
	Travisia brevis	1.0 (.079)	1.0 (.179)	1.0 (.032)	1.00 (.0967)												
Orbiniidae	Haploscoloplos elongata	2.0 (.008)	2.0 (.015)	1.0 (.004)	1.67 (.0090)		1.0 (.001)		0.33 (.0003)								
Oweniidae	Myriochele heeri					2.0 (.012)			0.67 (.0040)		1.0 (.001)	1.0 (.009)	0.67 (.0033)				
Paraonidae	Unknown sp.		1.0 (.001)		0.33 (.0003)	1.0 (.001)		1.0 (.001)	0.67 (.0007)	1.0 (.001)	1.0 (.001)		0.67 (.0007)	1.0 (.001)			0.33 (.0003)
	Aricidea longicornuta							1.0 (.003)	0.33 (.0010)	1.0 (.006)		5.0 (.020)	2.00 (.0087)		1.0 (.002)	4.0 (.005)	1.67 (.0023)
Pectinariidae	Pectinaria californiensis	2.0 (.060)			0.67 (.0200)	2.0 (.090)	2.0 (.045)		1.33 (.0450)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Spionidae	Laonice cirrata		2.0 (.387)	2.0 (.102)	1.33 (.1630)		3.0 (.927)	2.0 (.892)	1.67 (.6063)		2.0 (.559)	3.0 (1.130)	1.67 (.5630)	1.0 (.448)		1.0 (.128)	0.67 (.1920)
	Polydora sp.											1.0 (.001)	0.33 (.0003)				
	Prionospio malmgreni							2.0 (.018)	0.67 (.0060)		2.0 (.020)		0.67 (.0067)		1.0 (.004)		0.33 (.0013)
Sternaspidae	Sternaspis fossor		1.0 (.212)		0.33 (.0707)												
Trichobranchidae																	
	Terebellides stroemi	3.0 (.048)			1.00 (.0160)			3.0 (.024)	1.00 (.0080)	1.0 (.001)	1.0 (.010)	3.0 (.013)	1.67 (.0080)			1.0 (.012)	0.33 (.0040)
	Trichobranchus glacilis		4.0 (.030)		1.33 (.0100)					1.0 (.002)			0.33 (.0007)				
	Unknown sp							1.0 (.010)	0.33 (.0033)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	2	3	$\bar{x}$	Station 18: 1	2	3	$\bar{x}$	Station 19: 1	2	3	$\bar{x}$	Station 20: 1	2	3	$\bar{x}$
		Replicate and Mean Density and Biomass*															
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.	5.0 (.007)	2.0 (.001)		2.33 (.0027)	9.0 (.010)		21.0 (.024)	10.00 (.0113)			1.0 (.001)	0.33 (.0003)		2.0 (.006)	1.0 (.003)	1.0 (.0030)
	Bittium subplanatum	5.0 (.080)	1.0 (.007)	2.0 (.058)	2.67 (.0483)	1.0 (.018)			0.33 (.0060)			1.0 (.007)	0.33 (.0023)	1.0 (.007)			0.33 (.0023)
	Mitrella gouldi	1.0 (.066)			0.33 (.0220)	2.0 (.006)	1.0 (.071)	7.0 (.192)	3.33 (.0897)		2.0 (.072)	2.0 (.074)	1.33 (.0487)	6.0 (.359)	4.0 (.266)		3.33 (.2083)
	Nassarius mendicus													1.0 (.313)			0.33 (.1043)
	Oenopota sp.			1.0 (.010)	0.33 (.0033)									1.0 (.062)			0.33 (.0207)
	Polinices sp.													1.0 (.841)			0.33 (.2803)
Opisthobranchia	Turbonilla sp.					1.0 (.003)		1.0 (.003)	0.67 (.0020)	1.0 (.004)			0.33 (.0013)	2.0 (.046)	2.0 (.023)		1.33 (.0230)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Ascila castrensis	1.0 (.482)			0.33 (.1607)						1.0 (.227)		0.33 (.0757)		2.0 (.782)	1.0 (.748)	1.0 (.5100)
	Axinopsida serricata	149.0 (.820)	165.0 (.093)	88.0 (.653)	134.0 (.7920)	172.0 (.956)	87.0 (.498)	221.0 (1.147)	160.0 (.8670)	91.0 (.503)	115.0 (.719)	154.0 (.835)	120.0 (.6857)	123.0 (.870)	207.0 (1.119)	141.0 (.600)	157.0 (.8630)
	Cardiomya oldroydi	2.0 (.011)	2.0 (.014)	1.0 (.031)	1.67 (.0187)		2.0 (.008)	1.0 (.009)	1.0 (.0057)	1.0 (.004)			0.33 (.0013)		1.0 (.006)		0.33 (.0020)
	Compsomyax subdiaphana			1.0 (1.107)	0.33 (.3690)			3.0 (.284)	1.0 (.0947)	1.0 (.370)			0.33 (.1233)		1.0 (.033)	2.0 (.282)	1.0 (.1050)
	Lucinoma annulata					2.0 (.815)		1.0 (.291)	1.0 (.3687)		3.0 (.178)	1.0 (.123)	1.33 (.1003)				
	Macoma alaskansis	1.0 (.029)	10.0 (.342)	4.0 (.176)	5.0 (.1823)	3.0 (.346)	1.0 (.141)	4.0 (.530)	2.67 (.3390)			1.0 (.048)	0.33 (.0160)			1.0 (.074)	0.33 (.0247)
	Macoma carlottensis	25.0 (.463)	19.0 (.277)	17.0 (.320)	20.33 (.3533)	41.0 (.797)	32.0 (.350)	49.0 (.930)	40.67 (.6923)	5.0 (.172)	13.0 (.088)	6.0 (.182)	8.0 (.1473)	4.0 (.052)	11.0 (.221)	9.0 (.248)	8.0 (.1737)
	Macoma inquinata	1.0 (.072)			0.33 (.0240)	6.0 (.395)			2.0 (.1317)					1.0 (.062)			0.33 (.0207)
	Megacrenella columbiana	1.0 (.063)	1.0 (.002)	1.0 (.025)	1.0 (.0300)			1.0 (.005)	0.33 (.0017)								
	Nemocardium sp.		2.0 (.448)		0.67 (.1493)		1.0 (.047)		0.33 (.0157)	1.0 (.015)			0.33 (.0050)				
	Nucula tenuis	1.0 (.024)	4.0 (.071)	2.0 (.053)	2.33 (.0493)	2.0 (.003)	3.0 (.033)	10.0 (.116)	5.0 (.0507)			3.0 (.015)	1.0 (.0050)	1.0 (.010)	2.0 (.027)	2.0 (.043)	1.67 (.0267)
	Nuculana minuta	14.0 (.603)	19.0 (.608)	7.0 (.209)	13.33 (.4733)	10.0 (.577)	8.0 (.294)	9.0 (.437)	9.0 (.4360)	1.0 (.007)	1.0 (.031)		0.67 (.0127)	4.0 (.041)	1.0 (.015)	2.0 (.078)	2.33 (.0447)
	Paravalucina tenuisculptis													1.0 (.461)		1.0 (.297)	0.67 (.2527)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

		Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ERRANTIA	Density	10.0	19.0	11.0	13.33	11.0	12.0	24.0	15.66	10.0	13.0	24.0	15.65	7.0	16.0	14.0	12.33
	Biomass	.045	.211	.158	.1379	.417	.260	.264	.3136	.046	.246	.388	.2266	.079	.531	.159	.2563
	Number of species	5.0	6.0	5.0	5.33	7.0	5.0	6.0	6.00	5.0	4.0	8.0	5.67	4.0	6.0	5.0	5.00
SEDENTARIA	Density	23.0	49.0	25.0	32.33	21.0	33.0	43.0	32.34	33.0	29.0	42.0	34.68	16.0	25.0	26.0	22.32
	Biomass	.596	1.945	.450	.9970	.540	1.513	2.260	1.4373	1.364	.948	1.592	1.3014	.647	.931	1.199	.9345
	Number of species	7.0	9.0	6.0	7.33	8.0	6.0	11.0	8.33	7.0	8.0	10.0	8.33	5.0	5.0	6.0	5.33
GASTROPODA	Density	11.0	3.0	3.0	5.66	13.0	1.0	29.0	14.33	1.0	2.0	4.0	2.32	12.0	8.0	1.0	6.98
	Biomass	.153	.008	.068	.0763	.037	.071	.219	.1090	.004	.072	.082	.0526	1.628	.295	.003	.6419
	Number of species	3.0	2.0	2.0	2.33	4.0	1.0	3.0	2.67	1.0	1.0	3.0	1.67	6.0	3.0	1.0	3.33
PELECYPODA	Density	195.0	222.0	121.0	179.32	236.0	134.0	299.0	223.0	100.0	133.0	165.0	132.65	134.0	225.0	159.0	172.66
	Biomass	2.567	2.665	2.574	2.6019	3.889	1.371	3.749	3.0032	1.071	1.243	1.203	1.1723	1.496	2.203	2.370	2.0232
	Number of species	9.0	8.0	8.0	8.33	7.0	7.0	9.0	7.67	6.0	5.0	5.0	5.33	6.0	7.0	8.0	7.00
TOTAL	Density	239.0	293.0	160.0	230.64	281.0	180.0	395.0	285.33	144.0	177.0	235.0	185.33	169.0	274.0	200.0	214.29
	Biomass	3.361	4.829	3.250	3.8131	4.883	3.215	6.492	4.8631	2.485	2.509	3.265	2.7529	3.877	3.960	3.731	3.8559
	Number of species	24.0	25.0	21.0	23.32	26.0	19.0	29.0	24.67	19.0	18.0	26.0	21.0	21.0	21.0	20.0	20.66

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

		Replicate and Mean Density and Biomass*															
		Station 1,5,9,13,17				Station 2,6,10,14,18				Station 3,7,11,15,19				Station 4,8,12,16,20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
TOTAL (TABLE)	Density	912.0	1202.0	519.0	877.43	698.0	447.0	588.0	577.63	369.0	272.0	411.0	350.64	691.0	813.0	489.0	664.25
	Biomass	14.952	20.794	10.206	15.3164	13.5080	7.438	8.968	9.9700	10.971	5.322	5.536	7.6115	22.165	11.912	10.319	14.7985
	Number of species	76.0	87.0	73.0	78.65	69.0	55.0	56.0	59.98	55.0	41.0	48.0	48.00	76.0	68.0	68.0	70.65

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: x̄	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: x̄	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: x̄	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: x̄
		Replicate and Mean Density and Biomass*															
Sipuncula	Unknown sp.		2.0 (.770)		0.67 (.2567)					1.0 (.010)	1.0 (.010)	1.0 (.013)	1.00 (.0110)		1.0 (.020)		0.33 (.0067)
Nemertea																	
Cerebratula	Adult sp.		2.0 (.308)	1.0 (.300)	1.00 (.2027)											1.0 (.208)	0.33 (.0693)
Arthropoda																	
Crustacea																	
Malacostraca	Pinnixia sp.	1.0 (.023)			0.33 (.0077)												
Amphipoda	Unknown sp.	2.0 (.010)	2.0 (.010)		1.33 (.0067)					3.0 (.015)		2.0 (.003)	1.67 (.0060)				

****

	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: x̄	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: x̄	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: x̄	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: x̄
Density	3.0	6.0	1.0	3.33					4.0	1.0	3.0	2.67		1.0	1.0	0.66
Biomass	.033	1.088	.300	.4738					.025	.010	.016	.0170		.020	.208	.0760
Number of Species	2.0	3.0	1.0	2.00					2.0	1.0	2.0	1.67		1.0	1.0	0.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Nemertea																	
Cerebratulus	Adult sp.		1.0 (.035)		0.33 (.0117)	1.0 (.004)			0.33 (.0013)						1.0 (.410)		0.33 (.1367)
	Juvenile sp.							1.0 (.002)	0.33 (.0007)								
Arthropoda																	
Crustacea																	
Amphipoda	Unknown sp.	1.0 (.007)	2.0 (.010)		1.00 (.0057)						1.0 (.003)	1.0 (.001)	0.67 (.0013)				
								******	******								
	Density	1.0	3.0		1.33	1.0		1.0	0.66		1.0	1.0	0.67		1.0		0.33
	Biomass	.007	.045		.0174	.004		.002	.0020		.003	.001	.0013		.410		.1367
Number of Species		1.0	2.0		1.00	1.0		1.0	0.67		1.0	1.0	0.67		1.0		0.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum Class Subclass Order Family	Scientific Name	Station 9 1	Station 9 2	Station 9 3	Station 9 $\bar{x}$	Station 10 1	Station 10 2	Station 10 3	Station 10 $\bar{x}$	Station 11 1	Station 11 2	Station 11 3	Station 11 $\bar{x}$	Station 12 1	Station 12 2	Station 12 3	Station 12 $\bar{x}$
Nemertea																	
Cerebratulus	Juvenile sp.					1.0 (.013)			0.33 (.0043)						1.0 (.064)		0.33 (.0213)
Arthropoda																	
Crustacea																	
Malacostraca	Unknown sp.									1.0 (.006)			0.33 (.0020)				
Decapoda	Shrimp														1.0 (.502)	4.0 (.005)	1.67 (.1690)
Amphipoda	Unknown sp.											1.0 (.006)	0.33 (.0020)	1.0 (.008)			0.33 (.0027)
							*************										
	Density					1.0			0.33	1.0		1.0	0.66	1.0	2.0	4.0	2.33
	Biomass					.013			.0043	.006		.006	.0040	.008	.566	.005	.1930
Number of Species						1.0			0.33	1.0		1.0	0.67	1.0	2.0	1.0	1.33

Replicate and Mean Density and Biomass*

130

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13: 1	Station 13: 2	Station 13: 3	Station 13: x̄	Station 14: 1	Station 14: 2	Station 14: 3	Station 14: x̄	Station 15: 1	Station 15: 2	Station 15: 3	Station 15: x̄	Station 16: 1	Station 16: 2	Station 16: 3	Station 16: x̄
		Replicate and Mean Density and Biomass*															
Sipuncula	Unknown sp.					1.0 (.052)	2.0 (.090)		1.00 (.0473)							2.0 (.014)	0.67 (.0047)
Nemertea																	
Cerebratulus	Adult sp.		1.0 (.012)		0.33 (.0040)		1.0 (.103)	2.0 (.060)	1.00 (.0543)					2.0 (.230)			0.67 (.0767)
	Juvenile sp.	1.0 (.017)			0.33 (.0057)											1.0 (.026)	0.33 (.0087)
Arthropoda																	
Crustacea																	
Malacostraca	Unknown sp									1.0 (.002)			0.33 (.0007)	3.0 (.048)			1.00 (.0160)
Decapoda	Unknown sp.		1.0 (.115)		0.33 (.0383)												
Amphipoda	Unknown sp.	2.0 (.010)	3.0 (.007)		1.67 (.0057)	1.0 (.007)			0.33 (.0023)					1.0 (.002)	1.0 (.003)	1.0 (.005)	1.00 (.0033)
	************																
	Density	3.0	5.0		2.66	2.0	3.0	2.0	2.33	1.0			0.33	6.0	1.0	4.0	3.67
	Biomass	.027	.134		.0537	.059	.193	.060	.1039	.002			.0007	.280	.003	.045	.1094
Number of Species		2.0	3.0		1.67	2.0	2.0	1.0	1.67	1.0			0.33	3.0	1.0	3.0	2.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 15 June 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	Station 17: 2	Station 17: 3	Station 17: $\bar{x}$	Station 18: 1	Station 18: 2	Station 18: 3	Station 18: $\bar{x}$	Station 19: 1	Station 19: 2	Station 19: 3	Station 19: $\bar{x}$	Station 20: 1	Station 20: 2	Station 20: 3	Station 20: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Sipuncula	Unknown sp.		1.0 (.020)	1.0 (.108)	0.67 (.0427)		2.0 (.058)	1.0 (.024)	1.00 (.0273)						1.0 (.010)		0.33 (.0033)
Nemertea																	
Cerebratulus	Juvenile sp.	3.0 (.047)		1.0 (.052)	1.33 (.0330)	1.0 (.006)	2.0 (.118)	3.0 (.115)	2.00 (.0797)		2.0 (.315)	3.0 (.146)	1.67 (.1537)			1.0 (.047)	0.33 (.0157)
Arthropoda																	
Crustacea																	
Malacostraca	Unknown sp.							1.0 (.008)	0.33 (.0027)	1.0 (.010)		1.0 (.008)	0.67 (.0060)				
Decapoda	Unknown sp.										1.0 (.053)		0.33 (.0177)				
Amphipoda	Unknown sp.	4.0 (.011)	12.0 (.032)	7.0 (.010)	7.67 (.0177)		2.0 (.010)		0.67 (.0033)		2.0 (.005)	2.0 (.001)	1.33 (.0020)	2.0 (.008)	1.0 (.005)	2.0 (.002)	1.67 (.0050)
Tanadacea	Unknown sp.	1.0 (.001)	3.0 (.003)		1.33 (.0013)	4.0 (.005)		2.0 (.002)	2.00 (.0023)								
	************																
	Density	8.0	16.0	9.0	11.0	5.0	6.0	7.0	6.00	1.0	5.0	6.0	4.00	2.0	2.0	3.0	2.33
	Biomass	.059	.055	.170	.0947	.011	.186	.149	.1153	.010	.373	.155	.1794	.008	.015	.049	.0240
	Number of Species	3.0	3.0	3.0	3.00	2.0	3.0	4.0	3.00	1.0	3.0	3.0	2.33	1.0	2.0	2.0	1.67
	************																
Cumulative	Density	15.0	30.0	10.0	18.32	9.0	9.0	10.0	9.32	7.0	7.0	11.0	8.33	9.0	7.0	12.0	9.32
Cumulative	Biomass	.126	1.322	.470	.6396	.087	.379	.211	.2255	.043	.386	.178	.2024	.296	1.014	.307	.5391
Cumulative	Number of Species	8.0	11.0	4.0	7.67	6.0	5.0	6.00	5.67	5.0	5.0	7.0	5.67	5.0	7.0	7.0	6.33

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 June 1976 , Elliott Bay

	Station 1				Station 2				Station 3				Station 4			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
pth	197.0	198.0	200.0	198.33	198.0	200.0	200.0	199.33	202.0	215.0	214.0	210.33	218.0	218.0	218.0	218.00
mple Volume - Litres	13.0	13.0	15.5	13.83	8.0	10.0	5.5	7.83	7.0	7.0	8.0	7.33	13.0	14.0	12.0	13.00
mple Residue ml/1	96.2	375.0	64.5	178.57	162.5	37.5	381.8	193.93	100.0	185.8	150.0	145.23	123.1	92.9	141.7	119.23
rcent Rock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lume Rock ml/1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rcent Wood & Fibers	99.7	24.0	100.0	74.57	99.2	100.0	99.9	99.70	100.0	99.9	95.0	98.30	99.9	99.8	99.9	99.87
lume Wood & Fibers ml/1	96.1	90.4	64.5	83.67	161.3	37.5	381.8	193.53	100.0	185.7	150.0	145.23	123.1	92.8	141.7	119.20
rcent Wood	16.9	4.4	20.0	13.77	26.1	20.0	69.0	38.38	60.0	13.0	55.0	42.67	23.1	11.5	24.1	19.57
lume Wood ml/1	16.3	16.6	12.9	15.27	42.5	7.5	263.6	104.53	60.0	24.3	82.5	55.60	28.5	10.7	34.2	24.47
rcent Fibers	82.9	19.6	80.0	60.83	73.1	80.0	30.9	61.33	40.0	86.9	45.0	57.30	76.8	88.3	75.8	80.30
lume Fibers ml/1	79.8	73.8	51.6	68.40	118.8	30.0	118.2	89.00	40.0	161.4	67.5	89.63	94.6	82.1	107.5	94.73
rficial Layer Thickness	¼	¼	1/8		¼	1/8	¼		1/8	1/8	1/8		¼	1/8	1/8	
lor Sediment	B/b	B/b	B/b		B/b	B/b	B/b		G/b/G	B/b	B/b		B/b	B/b	B/b	
S Odor	YES	YES	NO		YES	YES	YES		NO	NO	YES		NO	YES	NO	
sociated Debris																
Oil	X	X	X		X	X				X	X		X	X	X	
Coal																
Seeds	X		X		X									X		
Metals														X		
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 June 1976 , Elliott Bay

	Station 5				Station 6				Station 7				Station 8			
	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
epth	192.0	194.0	194.0	193.33	196.0	192.0	195.0	194.33	201.0	215.0	201.0	205.67	211.0	210.0	210.0	210.33
ample Volume - Litres	5.0	9.0	5.0	6.33	6.0	7.0	5.0	6.00	6.0	3.0	3.0	4.00	8.0	10.0	9.0	9.00
ample Residue ml/1	280.0	172.2	280.0	244.07	275.0	171.4	175.0	207.13	116.6	166.6	133.3	138.83	237.5	120.0	200.0	185.83
ercent Rock	0	0	0	0	0	0	8.1	2.70	9.9	0	0	3.30	0	0	0	0
olume Rock ml/1	0	0	0	0	0	0	14.3	4.77	11.6	0	0	3.87	0	0	0	0
ercent Wood & Fibers	99.9	100.2	99.9	100.00	99.9	99.7	91.8	97.13	89.9	99.9	99.4	96.40	99.9	99.9	100.0	99.93
olume Wood & Fibers ml/1	280.0	172.6	280.0	244.20	275.0	171.4	160.8	202.40	104.9	166.6	133.2	134.90	237.5	120.0	200.0	185.83
ercent Wood	47.1	57.2	34.2	46.17	45.7	20.4	58.1	41.40	50.0	45.0	49.5	48.17	49.4	25.8	57.5	44.23
olume Wood ml/1	132.0	98.5	96.0	108.83	125.8	35.0	101.8	87.53	58.3	75.0	66.6	66.63	117.5	31.0	115.0	87.83
ercent Fibers	52.8	43.0	65.7	53.83	54.2	79.5	33.7	55.80	39.9	54.9	49.9	48.23	50.5	74.1	42.5	55.70
olume Fibers ml/1	148.0	74.1	184.0	135.37	149.2	136.4	59.0	114.87	46.6	91.6	66.6	68.27	120.0	89.0	85.0	98.00
urficial Layer Thickness	1/8	¼	¼		1/8	¼	1/8		¼	1/8	1/8		1/8	1/8	¼	
olor Sediment	B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
S Odor	YES	YES	YES		NO	S	YES		NO	YES	YES		YES	YES	YES	
ssociated Debris																
Oil	X	X	X		X	X	X			X	X		X	X	X	
Coal					X											
Seeds	X	X			X								X	X		
Metals		X												X		
Glass	X									X						
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 June 1976 , Elliott Bay

	Station 9				Station 10				Station 11				Station 12			
	1	2	3	x	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ɛpth	188.0	190.0	188.0	188.67	188.0	188.0	186.0	187.33	188.0	188.0	195.0	190.33	200.0	202.0	200.0	200.67
mple Volume - Litres	4.5	5.0	5.0	4.50	10.0	8.3	11.0	9.77	8.0	6.0	8.0	7.33	11.0	5.5	8.5	8.33
mple Residue ml/l	94.4	262.5	295.0	217.30	37.5	72.7	163.6	91.27	43.8	41.6	43.8	43.07	238.6	445.5	264.7	316.27
ercent Rock	.5	0	0	0.17	0	.9	.3	.40	4.3	39.9	0	14.73	0	0	0	0
olume Rock ml/l	1.0	0	0	0.33	0	.7	6.0	2.23	15.3	16.6	0	10.63	0	0	0	0
rcent Wood & Fibers	93.7	100.0	96.2	96.63	100.0	99.0	85.1	94.70	70.0	60.0	99.9	76.63	99.0	99.9	99.9	99.60
olume Wood & Fibers ml/l	182.3	262.6	236.1	227.00	37.5	72.1	139.5	83.03	30.7	25.0	43.8	33.17	238.6	455.5	264.7	319.60
rcent Wood	50.5	50.0	48.0	49.50	40.0	9.6	43.5	31.03	15.0	10.0	20.0	15.0	19.9	39.3	25.5	28.23
olume Wood ml/l	98.3	131.3	117.8	115.80	15.0	6.6	71.3	30.97	6.6	4.2	8.8	6.53	47.7	175.5	67.6	90.93
ercent Fibers	43.2	50.0	48.2	47.13	60.0	90.0	41.6	63.87	55.0	50.0	79.9	61.63	80.0	60.6	74.4	71.67
olume Fibers ml/l	84.0	131.3	118.3	111.20	22.5	65.5	68.2	52.06	24.1	20.8	35.0	26.63	190.9	270.0	197.1	219.03
rficial Layer Thickness	½	½	½		1/8	1/8	1/8		1/8	1/8	1/8		1/8	1/8	1/8	
olor Sediment	B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
S Odor	YES	S	YES		YES	YES	YES		YES	YES	NO		YES	YES	YES	
sociated Debris																
Oil	X	X	X		X	X	X			X	X		X	X	X	
Coal																
Seeds			X				X						X			
Metals							X									
Glass						X			X							
Brick																
Blue Clay							X		.X							

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 June 1976 , Elliott Bay

	Station 13				Station 14				Station 15				Station 16			
	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
pth	173.0	172.0	174.0	173.00	174.0	174.0	176.0	174.67	182.0	182.0	182.0	182.00	194.0	194.0	195.0	194.33
mple Volume - Litres	9.0	9.0	10.5	9.50	9.0	8.5	7.5	8.33	7.5	8.0	9.0	8.17	14.0	12.0	9.0	11.67
mple Residue ml/l	77.8	88.9	95.2	87.30	150.0	82.4	173.3	135.23	186.7	136.5	66.7	129.97	64.3	108.3	250.0	140.87
rcent Rock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
lume Rock ml/l	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rcent Wood & Fibers	99.9	99.8	99.9	99.87	99.6	99.8	99.8	99.77	99.9	99.9	45.9	81.90	99.8	99.8	97.7	99.10
lume Wood & Fibers ml/l	78.8	88.8	95.2	87.60	150.0	82.3	173.3	135.20	186.7	137.5	66.7	130.30	64.2	108.3	244.4	138.97
rcent Wood	10.0	49.9	9.9	8.27	13.7	9.0	16.9	13.20	25.0	18.1	5.9	16.33	14.0	21.5	15.7	17.07
lume Wood ml/l	7.8	4.4	9.5	7.23	20.6	8.2	29.3	19.37	46.7	25.0	40.0	37.23	9.6	23.3	39.4	24.10
rcent Fibers	89.9	94.9	90.0	91.60	86.2	89.9	83.0	86.37	74.9	81.8	40.0	65.57	84.9	78.4	82.0	81.77
lume Fibers ml/l	70.0	84.4	85.7	80.03	129.4	74.1	144.0	115.83	140.0	112.5	26.7	93.06	54.6	85.0	205.0	114.87
rficial Layer Thickness	1/8	1/8	1/8		¼	¼	¼		¼	¼	¼		1/8	¼	1/8	
lor Sediment	B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
S Odor	YES	YES	S		S	YES	S		YES	YES	YES		NO	YES	YES	
sociated Debris																
Oil					X		X		X	X	X			X		
Coal							X									
Seeds		X					X									
Metals	X															
Glass													X			
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 15 June 1976

	Station 17				Station 18				Station 19				Station 20			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
pth	200.0	160.0	170.0	176.67	185.0	170.0	184.0	179.67	152.0	168.0	162.0	160.67	190.0	170.0	168.0	176.00
mple Volume - Litres	6.5	4.5	5.0	5.33	9.0	7.5	9.0	8.50	10.0	10.0	12.0	10.67	9.0	11.0	8.0	9.33
mple Residue ml/1	107.7	44.4	100.0	84.03	55.6	86.7	55.6	65.97	117.5	50.0	33.3	66.93	172.2	54.5	162.5	129.57
rcent Rock	97.9	98.1	98.0	98.00	10.8	97.9	97.9	68.87	37.7	95.0	93.0	75.23	74.2	70.0	83.8	76.00
lume Rock ml/1	105.5	43.6	98.0	82.37	54.4	84.9	54.4	64.57	44.3	47.5	31.0	40.93	127.9	38.2	136.3	100.80
rcent Wood & Fibers	2.0	.1	1.0	1.03	.9	2.0	1.8	1.57	2.6	5.0	7.2	4.93	25.6	30.9	16.0	24.17
lume Wood & Fibers ml/1	2.1	.8	2.0	1.63	1.1	1.7	1.1	1.30	3.1	2.5	2.1	2.57	44.3	16.4	26.2	28.97
rcent Wood	1.0	.1	0	.37	0	1.0	.9	.63	1.0	4.0	5.1	3.37	4.5	10.9	8.0	7.80
lume Wood ml/1	1.0	.4	1.0	.80	.5	.8	.5	.60	1.1	2.0	1.7	1.60	7.9	5.5	13.1	8.83
rcent Fibers	1.0	0	1.0	.67	.9	1.0	.9	.93	1.6	1.0	2.1	1.57	21.1	20.0	8.0	16.37
lume Fibers ml/1	1.0	.4	1.0	.80	.5	.8	.5	.60	1.9	.5	.7	1.03	36.4	10.9	13.1	20.13
rficial Thickness Layer	1/8	1/8	1/8		1/8	1/8	1/8		1/8	1/8	1/8		1/8	1/8	1/8	
lor Sediment	B/b	B/b	B/b		B/g	B/g	B/g		B/g	B/g	B/g		B/g/b	B/g	B/g	
S Odor	YES	S	YES		NO	YES	YES		YES	S	YES		NO	NO	NO	
sociated Debris																
Oil										X						
Coal										X			X		X	
Seeds									X				X			
Metals																
Glass									X				X		X	
Brick																
Blue Clay																

Density of Worm Tubes, Elliott Bay
June 15, 1976

		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF3														2.0		0.67
	MF5						1.0		0.33						2.0		0.67
	MF6		4.0		1.33			2.0	0.67		1.0		0.33		2.0		0.67
	MF8													1.0			0.33
	MR3			2.0	0.67					2.0	6.0		2.67	6.0	2.0	2.0	3.33
	MR8										2.0		0.67				
	MR9	2.0			0.67		9.0		3.0								
Sand Tubes	SF9		2.0	1.0	1.00						1.0		0.33				
	SR1		4.0		1.33	1.0			0.33	2.0			0.67				
	SR3											4.0	1.33	2.0			0.67
	SR4		4.0	9.0	4.33					5.0	9.0		4.67	10.0	8.0	13.0	10.33
	SR7	408.0	413.0	220.0	347.0	11.0		12.0	7.67	1.0	41.0		14.0	68.0	59.0	86.0	71.0
	SR10									3.0			1.0				
	SR14									2.0			0.67				
	SR18							6.0	2.00			1.0	0.33				
	SC1	2.0	1.0	1.0	1.33			2.0	0.67	2.0			0.67		8.0		2.57
	SC5							1.0	0.33			1.0	0.33		1.0		0.33
Mucous Membrane Tubes	MM4	10.0		7.0	5.67	1.0		4.0	1.67	2.0	12.0		4.67	15.0	14.0	14.0	14.33

Density of Worm Tubes, Elliott Bay
June 15, 1976

		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF3									2.0	6.0		2.67	3.0			1.00
	MF5		2.0	1.0	1.00												
	MF6	2.0		1.0	1.00												
	MR3		1.0		0.33		1.0		0.33						1.0	2.0	1.00
	MR9	10.0			3.33	25.0			8.33					15.0	1.0		5.33
Sand Tubes	SR3														3.0		1.00
	SR7	30.0	426.0	47.0	167.67	360.0	67.0		142.33	1.0	3.0		1.33	47.0	54.0	6.0	35.67
	SC1		8.0	1.0	3.00		4.0	1.0	1.67					1.0			0.33
	SC5					4.0		1.0	1.67			2.0	0.67				
Mucous Membrane Tubes	MF14	2.0	6.0	6.0	4.67	7.0			2.33								

Density of Worm Tubes, Elliott Bay
June 15, 1976

		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF6	1.0			0.33									2.0			0.67
	MR3										11.0		3.67	1.0			0.33
	MR9					3.0		10.0	4.33	15.0	1.0	50.0	22.00			6.0	2.00
Sand Tubes	SR4													4.0	2.0		2.00
	SR7	1.0			0.33			1.0	0.33		1.0		0.33	73.0	24.0	32.0	43.00
	SR18		1.0		0.33		1.0		0.33						1.0		0.33
	SC1										1.0		0.33	8.0			2.67
	SC2									1.0			0.33				
	SC5						1.0	2.0	1.00						4.0	1.0	1.67
	SI2 & 3	1.0			0.33												
Mucous Membrane Tubes	MM4	3.0			1.00									3.0		1.0	1.33

Density of Worm Tubes, Elliott Bay
June 15, 1976

		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF6	2.0		2.0	1.33	1.0	3.0		1.33							1.0	0.33
	MR3	3.0			1.00									2.0			0.67
	MR8											1.0	0.33				
	MR9			2.0	0.67			4.0	1.33	1.0	1.0	5.0	2.33				
Sand Tubes	SF9	2.0			0.67									1.0		3.0	1.33
	SR1	9.0	10.0		6.33			4.0	1.33			5.0	1.67				
	SR3	2.0	2.0		1.33	3.0	3.0		2.00								
	SR4	6.0			2.00	6.0	4.0		3.33	5.0	3.0		2.67	14.0		1.0	5.00
	SR7	12.0	15.0	7.0	11.33	3.0	25.0	22.0	16.67			1.0	0.33	51.0	105.0	187.0	114.33
	SR14	3.0			1.00	1.0			0.33								
	SR16	1.0			0.33	16.0			5.33								
	SR18	1.0	1.0		0.67					4.0			1.33			1.0	0.33
	SI 2 & 3		1.0		0.33												
	SC1	26.0	42.0	9.0	25.67	4.0	3.0	4.0	3.67	3.0	3.0	5.0	3.67	1.0	4.0	6.0	3.67
	SC2	1.0	1.0		0.67	2.0			0.67								
	SC5							1.0	0.33	4.0	4.0		2.67				
Mucous Membrane Tubes	MM4	3.0	13.0	3.0	6.33	1.0	1.0		0.67	2.0	3.0		1.67	3.0			1.00

Density of Worm Tubes, Elliott Bay
June 15, 1976

		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF5	4.0			1.33		3.0	12.0	5.00								
	MF6													3.0		2.0	1.67
	MR3						2.0		0.67	3.0	3.0		2.00	3.0		2.0	1.67
	MR9													1.0			0.33
Sand Tubes	SF9	6.0		2.0	26.67		2.0	2.0	1.33		1.0		0.33				
	SR1	200.0	450.0	110.0	253.33	80.0	80.0	60.0	73.33	5.0			1.67		12.0	1.0	4.33
	SR3	3.0		2.0	1.67	2.0			0.67								
	SR4	9.0	15.0	3.0	9.00	20.0			6.67	27.0	4.0		10.33		6.0	6.0	4.00
	SR5	11.0	16.0	6.0	11.00	1.0	2.0	9.0	4.00								
	SR7	150.0	134.0	60.0	114.67	35.0	82.0	200.0	105.67	240.0	117.0		119.00	47.0	140.0	95.0	94.00
	SR10	60.0	200.0	52.0	104.00	24.0	20.0	8.0	17.33								
	SR14	3.0	11.0	9.0	7.67												
	SR16	2.0			0.67												
	SI 2 & 3	7.0	2.0	14.0	7.67	25.0	2.0		9.00								
	SC1	21.0	20.0	9.0	16.67	12.0	22.0	11.0	15.00	13.0	30.0		14.33	41.0	164.0	33.0	79.33
	SC2	1.0		3.0	1.33	1.0	4.0		1.67	9.0	8.0		5.67	1.0	2.0	3.0	2.00
Mucous Membrane Tubes	MM4	4.0			1.33			11.0	3.67		4.0		1.33				
	PC1	1.0	5.0	2.0	2.67												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1				Station 2				Station 3				Station 4			
		Replicate and Mean Density and Biomass*															
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	3.0 (.022)			1.00 (.0073)			1.0 (.075)	0.33 (.0250)		2.0 (.035)	4.0 (.081)	2.00 (.0387)	2.0 (.085)	1.0 (.053)	4.0 (.095)	2.33 (.0777)
Lumbrinerida	Lumbrineris bicurrata		1.0 (.120)	1.0 (.089)	0.67 (.0697)			2.0 (.042)	0.67 (.0140)						1.0 (.032)		0.33 (.0107)
	Lumbrineris luti		3.0 (.025)	2.0 (.013)	1.67 (.0127)			2.0 (.015)	0.67 (.0050)		3.0 (.019)	1.0 (.001)	1.33 (.0067)	1.0 (.002)		2.0 (.004)	1.00 (.0020)
Nephytidae	Nephtys ferruginea		2.0 (.027)	3.0 (.008)	1.67 (.0117)						2.0 (.010)	1.0 (.003)	1.00 (.0043)	1.0 (.001)			0.33 (.0003)
	Onuphis iridescens	2.0 (.280)			0.67 (.0933)			1.0 (.132)	0.33 (.0440)					2.0 (.417)	2.0 (.181)	1.0 (.032)	1.67 (.2100)
Phyllodocidae	Eteone sp.							2.0 (.025)	0.67 (.0083)		1.0 (.002)	1.0 (.003)	0.67 (.0017)				
	Phyllodoce groenlandica		1.0 (.002)		0.33 (.0007)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum Class Subclass Order Family	Scientific Name	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: $\bar{x}$	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: $\bar{x}$	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: $\bar{x}$	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Ampharete goesi		2.0 (.004)		0.67 (.0013)												
	Melinna cristata		1.0 (.032)		0.33 (.0107)												
Capitellidae	Heteromastus cf. filobranchus	2.0 (.018)	8.0 (.158)	2.0 (.038)	4.00 (.0713)			8.0 (.168)	2.67 (.0560)		2.0 (.020)	1.0 (.010)	1.00 (.0100)	3.0 (.102)	5.0 (.072)	3.0 (.119)	3.67 (.0977)
Maldanidae	Asychis similis		2.0 (.145)		0.67 (.0483)							1.0 (.052)	0.33 (.0173)				
	Euclymene zonalis	3.0 (.035)	6.0 (.100)	8.0 (.078)	5.67 (.0710)			2.0 (.015)	0.67 (.0050)		5.0 (.065)	1.0 (.002)	2.00 (.0223)	4.0 (.038)		7.0 (.026)	3.67 (.0213)
	Praxillella affinis										1.0 (.012)		0.33 (.0040)				
	Praxillella gracilis		1.0 (.060)		0.33 (.0200)					1.0 (.090)			0.33 (.0300)	1.0 (.432)			0.33 (.1440)
Pectinariidae	Pectinaria californiensis			2.0 (.028)	0.67 (.0093)										1.0 (.068)	3.0 (.072)	1.33 (.0467)
Spionidae	Laonice cirrata	1.0 (.437)			0.33 (.1457)						1.0 (.043)	1.0 (.092)	0.67 (.0450)	1.0 (.114)		1.0 (.368)	0.67 (.1607)
	Prionospio malmgreni									1.0 (.001)			0.33 (.0003)				
	Trichobranchus glacilis			1.0 (.018)	0.33 (.0060)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1				Station 2				Station 3				Station 4			
		Replicate and Mean Density and Biomass*															
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.			4.0 (.004)	1.33 (.0013)												
	Mitrella gouldi							2.0 (.130)	0.67 (.0433)			3.0 (.153)	1.00 (.0510)				
Opisthobranchia	Turbonilla sp.	1.0 (.010)	1.0 (.004)		0.67 (.0047)												
Pelecypoda (Bivalvia)	Axinopsida serricata	161.0 (1.087)	93.0 (.222)	110.0 (1.045)	121.33 (.7847)		17.0 (.142)		5.67 (.0473)		47.0 (.184)	114.0 (.477)	53.67 (.2203)	52.0 (.365)	56.0 (.301)	142.0 (.872)	83.33 (.5127)
	Compsomyax subdiaphana	1.0 (.128)		2.0 (.108)	1.00 (.0787)						1.0 (.233)		0.33 (.0777)				
	Lucinoma annulata														1.0 (.157)		0.33 (.0523)
	Macoma carlottensis	12.0 (.163)	13.0 (.306)	23.0 (.357)	16.00 (.2753)	1.0 (.010)		3.0 (.011)	1.33 (.0070)		10.0 (.422)	18.0 (.352)	9.33 (.2580)	11.0 (.124)	7.0 (.144)	24.0 (.173)	14.0 (.1470)
	Macoma secta															1.0 (.055)	0.33 (.0183)
	Nucula tenuis							2.0 (.016)	0.67 (.0053)			2.0 (.027)	0.67 (.0090)	1.0 (.016)	1.0 (.030)	1.0 (.015)	1.00 (.0203)
	Nuculana minuta					2.0 (.061)			0.67 (.0203)			3.0 (.070)	1.00 (.0233)	2.0 (.059)			0.67 (.0197)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

		Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	5.0	7.0	6.0	6.00			8.0	2.67		8.0	7.0	5.00	6.0	4.0	7.0	5.66
	Biomass	.302	.174	.110	.1954			.289	.0963		.066	.088	.0514	.505	.266	.131	.3007
	Number of species	2.0	4.0	3.0	3.00			5.0	1.67		4.0	4.0	2.67	4.0	3.0	3.0	3.33
SEDENTARIA	Density	6.0	20.0	13.0	13.00			10.0	3.34	2.0	9.0	4.0	4.99	9.0	6.0	15.0	10.00
	Biomass	.490	.499	.162	.3836			.183	.0610	.091	.140	.156	.1289	.686	.140	.585	.4701
	Number of species	3.0	6.0	4.0	.433			2.0	0.67	2.0	4.0	4.0	3.33	4.0	2.0	5.0	3.67
GASTROPODA	Density	1.0	1.0	4.0	2.00			2.0	0.67			3.0	1.00				
	Biomass	.010	.004	.004	.0060			.130	.0433			.153	.0510				
	Number of species	1.0	1.0	1.0	1.00			1.0	0.33			1.0	0.33				
Pelecypoda	Density	174.0	106.0	135.0	138.33	3.0	17.0	5.0	8.34		58.0	137.0	65.00	66.0	65.0	168.0	99.66
	Biomass	1.378	.528	1.510	1.1387	.071	.142	.027	.0799		.039	.926	.5883	.564	.632	1.115	.7703
	Number of species	3.0	2.0	3.0	2.67	2.0	1.0	2.0	1.67		3.0	4.0	2.33	4.0	4.0	4.0	4.00
TOTAL	Density	186.0	134.0	158.0	159.33	3.0	17.0	25.0	15.02	2.0	75.0	151.0	75.99	81.0	75.0	190.0	115.32
	Biomass	2.180	1.205	1.786	1.7237	.071	.142	.629	.2805	.091	1.045	1.323	.8194	1.755	1.040	1.831	1.5411
	Number of species	9.0	13.0	11.0	11.00	2.0	1.0	10.0	4.34	2.0	11.0	13.0	8.66	12.0	9.0	12.0	11.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	_Glycera capitata_													1.0 (.011)	2.0 (.074)		1.00 (.0283)
Goniadidae	_Glycinde armigera_	1.0 (.358)			0.33 (.1193)		1.0 (.250)		0.33 (.0833)								
Lumbrineridae	_Lumbrineris luti_															1.0 (.001)	0.33 (.0003)
	Ninoe gemma													1.0 (.019)	1.0 (.005)		0.67 (.0080)
Nephtyidae	_Nephtys ferruginea_													1.0 (.015)	1.0 (.001)	1.0 (.020)	1.00 (.0120)
Onuphidae	_Onuphis iridescens_														1.0 (.072)		0.33 (.0240)
	Eteone sp.											1.0 (.018)	0.33 (.0060)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Heteromastus cf. filobranchus	1.0 (.018)			0.33 (.0060)		2.0 (.030)	2.0 (.038)	1.33 (.0227)			1.0 (.023)	0.33 (.0077)	3.0 (.069)	2.0 (.065)	5.0 (.142)	3.33 (.0920)
Chaetopteridae	Chaetozone setosa														1.0 (.001)		0.33 (.0003)
Maldanidae	Euclymene zonalis			1.0 (.006)	0.33 (.0020)			1.0 (.001)	0.33 (.0003)					1.0 (.002)	2.0 (.020)	1.0 (.010)	1.33 (.0107)
Spionidae	Laonice cirrata													1.0 (.106)	1.0 (.380)		0.67 (.1620)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass* Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Gastropoda Prosobranchia	Mitrella gouldi									1.0 (.076)	1.0 (.095)		0.67 (.0570)				
Pelecypoda (Bivalvia)	Axinopsida serricata	1.0 (.002)		1.0 (.002)	0.67 (.0013)									24.0 (.120)	10.0 (.042)		11.33 (.0540)
	Macoma alaskansis	1.0 (.585)			0.33 (.1950)												
	Macoma carlottensis	2.0 (.003)		1.0 (.029)	1.00 (.0107)			1.0 (.043)	0.33 (.0143)			1.0 (.008)	0.33 (.0027)	17.0 (.376)	9.0 (.143)	1.0 (.008)	9.00 (.1757)
	Macoma secta											1.0 (.124)	0.33 (.0413)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

		Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	1.0			0.33		1.0		0.33			1.0	0.33	3.0	5.0	2.0	3.33
	Biomass	.358			.1193		.250		.0833			.018	.006	.045	.152	.021	.0727
	Number of species	1.0			0.33		1.0		0.33			1.0	0.33	3.0	4.0	2.0	3.00
SEDENTARIA	Density	1.0		1.0	0.66		2.0	3.0	1.67			1.0	0.33	5.0	6.0	6.0	5.66
	Biomass	.018		.006	.0080		.030	.039	.0230			.023	.0077	.177	.466	.152	.2650
	Number of species	1.0		1.0	0.67		1.0	2.0	1.00			1.0	0.33	3.0	4.0	2.0	3.00
GASTROPODA	Density									1.0	1.0		0.67				
	Biomass									.076	.095		.057				
	Number of species									1.0	1.0		0.67				
Pelecypoda	Density	4.0		2.0	2.00			1.0	0.33			2.0	0.66	41.0	19.0	1.0	20.33
	Biomass	.590		.031	.2070			.043	.0143			.132	.0440	.496	.185	.008	.2297
	Number of species	3.0		2.0	1.67			1.0	0.33			2.0	0.67	2.0	2.0	1.0	1.67
TOTAL	Density	6.0		4.0	3.32		3.0	4.0	2.33	1.0	1.0	4.0	1.99	49.0	30.0	9.0	29.32
	Biomass	.9960		.0370	.3343		.280	.082	.1206	.076	.095	.1730	.1147	.7180	.803	.181	.5674
	Number of species	5.0		3.0	2.67		2.0	3.0	1.67	1.0	1.0	4.0	2.00	8.0	10.0	5.0	7.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	1.0 (.170)	2.0 (.012)	1.0 (.007)	1.33 (.0630)									1.0 (.010)			0.33 (.0033)
Lumbrineridae	Lumbrineris luti	1.0 (.014)	1.0 (.001)		0.67 (.0050)												
Nephtyidae	Nephtys ferruginea	1.0 (.006)			0.33 (.0020)										1.0 (.048)		0.33 (.0160)
Onuphidae	Onuphis iridescens	1.0 (.023)			0.33 (.0077)						1.0 (.085)		0.33 (.0283)	1.0 (.140)			0.33 (.0467)
Phyllodocidae	Phyllodoce groenlandica	1.0 (.128)			0.33 (.0427)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Heteromastus cf. filobranchus	3.0 (.010)	1.0 (.023)	1.0 (.115)	1.67 (.0493)									1.0 (.020)	2.0 (.022)	2.0 (.022)	1.67 (.0213)
Maldanidae	Euclymene zonalis													1.0 (.013)			0.33 (.0043)
	Praxilella gracilis	1.0 (.370)			0.33 (.1233)												
Pectinariidae	Pectinaria californiensis	1.0 (.048)			0.33 (.0160)												
Spionidae	Laonice cirrata	1.0 (.038)	1.0 (.063)	1.0 (.068)	1.00 (.0563)												
Trichobranchidae	unknown sp.															1.0 (.061)	0.33 (.0203)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	*Natica clausa*	1.0 (.368)			0.33 (.1226)									1.0 (.053)			0.33 (.0177)
Pelecypoda (Bivalvia)	*Axinopsida serricata*	37.0 (.119)	2.0 (.010)	9.0 (.027)	16.00 (.0520)									4.0 (.026)	6.0 (.033)	9.0 (.027)	6.33 (.0287)
	Macoma alaskansis	2.0 (.384)	1.0 (.220)		1.00 (.2013)												
	Macoma carlottensis	3.0 (.058)	2.0 (.207)	11.0 (.454)	5.33 (.2397)	1.0 (.004)	1.0 (.002)		0.67 (.0020)					1.0 (.004)	14.0 (.099)	5.0 (.123)	6.67 (.0753)
	Nucula tenuis	1.0 (.012)		1.0 (.033)	0.67 (.0150)											1.0 (.021)	0.33 (.0070)
	Nuculana minuta			1.0 (.036)	0.33 (.0120)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

		Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	5.0	3.0	1.0	2.99						1.0		0.33	2.0	1.0		0.99
	Biomass	.341	.013	.007	.1198						.085		.028	.150	.048		.0660
	Number of species	5.0	2.0	1.0	2.67						1.0		0.33	2.0	1.0		1.00
SEDENTARIA	Density	6.0	2.0	2.0	3.33									2.0	2.0	3.0	2.33
	Biomass	.466	.086	.183	.2449									.033	.022	.083	.0459
	Number of species	4.0	2.0	2.0	2.67									2.0	1.0	2.0	1.67
GASTROPODA	Density	1.0			0.33									1.0			0.33
	Biomass	.368			.1226									.053			.0177
	Number of species	1.0			0.33									1.0			0.33
Pelecypoda	Density	43.0	5.0	22.0	23.33	1.0	1.0		0.67					5.0	20.0	15.0	13.33
	Biomass	.573	.437	.550	.5200	.004	.002		.0020					.030	.132	.171	.1110
	Number of species	4.0	3.0	4.0	3.67	1.0	1.0		0.67					2.0	2.0	3.0	2.33
TOTAL	Density	55.0	10.0	25.0	29.98	1.0	1.0		0.67		1.0		0.33	10.0	23.0	18.0	16.98
	Biomass	1.7480	.5360	.7400	1.0073	.004	.002		.0020		.085		.0280	.2660	.202	.254	.2406
	Number of species	14.0	7.0	7.0	9.33	1.0	1.0		0.67		1.0		0.33	7.0	4.0	5.0	5.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*	1.0 (.047)	1.0 (.020)	2.0 (.031)	1.33 (.0326)	2.0 (.032)	2.0 (.030)	4.0 (.118)	2.67 (.0600)	3.0 (.082)			1.0 (.0273)		1.0 (.014)	2.0 (.275)	1.00 (.0963)
Goniadidae	*Glycinde armigera*							1.0 (.012)	0.33 (.0040)						1.0 (.022)		0.33 (.0073)
Lumbrineridae	*Lumbrineris luti*		2.0 (.013)		0.67 (.0043)	2.0 (.009)			0.67 (.0030)	1.0 (.016)			0.33 (.0053)			1.0 (.025)	0.33 (.0083)
	Ninoe gemma															1.0 (.060)	0.33 (.0200)
Nephtyidae	*Nephtys ferruginea*	1.0 (.003)		3.0 (.083)	1.33 (.0286)		1.0 (.015)	2.0 (.019)	1.00 (.0113)	1.0 (.008)			0.33 (.0026)		1.0 (.056)	4.0 (.039)	1.67 (.0316)
Onuphidae	*Onuphis iridescens*					1.0 (.020)			0.33 (.0067)					1.0 (.177)		1.0 (.360)	0.67 (.1790)
Sigalionidae	*Pholoe minuta*															1.0 (.014)	0.33 (.0047)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13: 1	Station 13: 2	Station 13: 3	Station 13: $\bar{x}$	Station 14: 1	Station 14: 2	Station 14: 3	Station 14: $\bar{x}$	Station 15: 1	Station 15: 2	Station 15: 3	Station 15: $\bar{x}$	Station 16: 1	Station 16: 2	Station 16: 3	Station 16: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Heteromastus cf. filobranchus	5.0 (.220)	1.0 (.028)	5.0 (.203)	3.67 (.1503)	1.0 (.015)	1.0 (.003)		0.67 (.0060)	2.0 (.032)		2.0 (.082)	1.33 (.0380)	2.0 (.010)		1.0 (.021)	1.00 (.0103)
Maldanidae	Euclymene zonalis									1.0 (.003)			0.33 (.0010)	1.0 (.008)	1.0 (.010)	1.0 (.025)	1.00 (.0143)
	Praxilella gracilis					3.0 (.690)			1.00 (.2300)					1.0 (.488)	2.0 (.452)	1.0 (.261)	1.33 (.4003)
Opheliidae	Armandia brevis									1.0 (.012)			0.33 (.0040)				
Oweniidae	Myriochele heeri															1.0 (.020)	0.33 (.0067)
Paraonidae	Unknown sp.															1.0 (.002)	0.33 (.0007)
Pectinariidae	Pectinaria califoriensis			1.0 (.013)	0.33 (.0043)												
Spionidae	Laonice cirrata	1.0 (.090)	1.0 (.008)		0.67 (.0327)					1.0 (.207)			0.33 (.0690)		1.0 (.268)		0.33 (.0893)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Gastropoda Prosobranchia	Mitrella gouldi														1.0 (.153)	1.0 (.089)	0.67 (.0807)
	Oenopota sp.													1.0 (.028)		1.0 (.023)	0.67 (.0170)
	Polinices sp.		1.0 (.644)		0.33 (.2147)												
Pelecypoda (Bivalvia)	Axinopsida serricata	215.0 (1.672)	10.0 (.059)	18.0 (1.001)	81.00 (.9107)	74.0 (.466)	75.0 (.414)	29.0 (.138)	59.33 (.3393)	64.0 (.350)	1.0 (.002)	35.0 (.154)	33.33 (.1687)	91.0 (.779)	89.0 (.746)	159.0 (1.155)	113.00 (.8933)
	Compsomyax subdiaphana		1.0 (.085)	1.0 (.020)	0.67 (.0350)										1.0 (.052)		0.33 (.0173)
	Lucinoma annulata	1.0 (.083)		2.0 (.088)	1.00 (.0570)										2.0 (.232)		0.67 (.0773)
	Macoma alaskensis		2.0 (.269)	1.0 (.205)	1.00 (.1580)	3.0 (.640)		1.0 (.153)	1.33 (.2643)								
	Macoma carlottensis	27.0 (.819)	18.0 (.298)	34.0 (.353)	26.33 (.4900)	8.0 (.162)	31.0 (.534)	15.0 (.403)	18.00 (.3663)	21.0 (.388)	1.0 (.046)	9.0 (.181)	10.33 (.2050)	18.0 (.100)	39.0 (.435)	24.0 (.349)	27.00 (.2947)
	Macoma secta	1.0 (.057)	1.0 (.048)	1.0 (.051)	1.00 (.0520)		1.0 (.074)		0.33 (.0247)								
	Nucula tenuis	1.0 (.003)	2.0 (.007)		1.00 (.0033)	2.0 (.005)		1.0 (.011)	1.00 (.0053)	1.0 (.013)		3.0 (.084)	1.33 (.0323)	1.0 (.024)		1.0 (.020)	0.67 (.0147)
	Nuculana minuta	3.0 (.063)	1.0 (.002)	4.0 (.053)	2.67 (.0393)	1.0 (.075)	1.0 (.019)		0.67 (.0313)						1.0 (.005)		0.33 (.0017)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

		Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ERRANTIA	Density	2.0	3.0	5.0	3.33	5.0	3.0	7.0	5.00	5.0			1.67	1.0	3.0	10.0	4.66
	Biomass	.050	.033	.114	.0655	.061	.045	.149	.085	.106			.0353	.177	.092	.773	.3472
	Number of species	2.0	2.0	2.0	2.00	3.0	2.0	3.0	2.67	3.0			1.00	1.0	3.0	6.0	3.33
SEDENTARIA	Density	6.0	2.0	6.0	4.67	4.0	1.0		1.67	5.0		2.0	2.32	4.0	4.0	5.0	4.32
	Biomass	.310	.036	.216	.1873	.705	.003		.236	.254		.082	.1120	.506	.730	.329	.5216
	Number of species	2.0	2.0	2.0	2.00	2.0	1.0		1.00	4.0		1.0	1.67	3.0	3.0	5.0	3.67
GASTROPODA	Density	1.0			0.33									1.0	1.0	2.0	1.33
	Biomass	.644			.2147									.028	.153	.112	.0977
	Number of species	1.0			0.33									1.0	1.0	2.0	1.33
Pelecypoda	Density	248.0	35.0	61.0	114.67	88.0	108.0	46.0	80.66	86.0	2.0	47.0	44.99	110.0	132.0	184.0	142.00
	Biomass	2.697	.768	1.771	1.7453	1.348	1.041	.705	1.0312	.751	.048	.419	.4060	.903	1.470	1.524	1.2990
	Number of species	6.0	7.0	7.0	6.67	5.0	4.0	4.0	4.33	3.0	2.0	3.0	2.67	3.0	5.0	3.0	3.67
TOTAL	Density	256.0	41.0	72.0	123.00	97.0	112.0	53.0	87.33	96.0	2.0	49.0	48.98	116.0	140.0	201.0	152.31
	Biomass	3.057	1.481	2.101	2.2128	2.114	1.089	.854	1.3522	1.111	.048	.501	.5533	1.614	2.445	2.738	2.2655
	Number of species	10.0	11.0	11.0	10.67	10.0	7.0	7.0	8.00	10.0	2.0	4.0	5.33	8.0	12.0	16.0	12.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Errantia																	
Arabellidae	Notocirrus californiensis			1.0 (.127)	0.33 (.0423)												
Glyceridae	Glycera capitata	2.0 (.137)	2.0 (.082)	1.0 (.012)	1.67 (.0770)	3.0 (.068)	3.0 (.112)		2.00 (.0600)	2.0 (.340)	2.0 (1.710)	3.0 (.032)	2.33 (.6940)	3.0 (.076)	1.0 (.142)	2.0 (.015)	2.00 (.0776)
Goniadidae	Glycinde armigera		1.0 (.007)	1.0 (.018)	0.67 (.0083)						1.0 (.254)		0.33 (.0846)	1.0 (.132)			0.33 (.0440)
	Goniada brunnea											2.0 (.010)	0.67 (.0033)			2.0 (1.030)	0.67 (.3433)
Lumbrineridae	Lumbrineris luti		2.0 (.028)	2.0 (.017)	1.33 (.0150)		1.0 (.002)		0.33 (.0006)	3.0 (.029)		1.0 (.006)	1.33 (.0116)	1.0 (.001)	1.0 (.008)	1.0 (.008)	1.00 (.0056)
Nephtyidae	Nephtys ferruginea	1.0 (.017)	1.0 (.004)		0.67 (.0070)	3.0 (.013)			1.00 (.0043)	1.0 (.013)	1.0 (.014)		0.67 (.0090)	1.0 (.008)		3.0 (.052)	1.33 (.0200)
Onuphidae	Onuphis iridescens	1.0 (.008)		1.0 (.005)	0.67 (.0043)	2.0 (.238)		1.0 (.005)	1.00 (.0810)	2.0 (.022)	2.0 (.189)	2.0 (.288)	2.00 (.1663)			3.0 (.067)	1.00 (.0223)
Phyllodocidae	Planktonic phyllodocidae										1.0 (.010)		0.33 (.0033)				
Polynoidae	Unknown sp.										1.0 (.013)		0.33 (.0043)				
Syllidae	Syllis harti		1.0 (.012)		0.33 (.0040)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Heteromastus cf. filobranchus	4.0 (.109)	10.0 (.278)	12.0 (.340)	8.67 (.2423)	9.0 (.162)	5.0 (.266)	1.0 (.005)	5.00 (.1443)	25.0 (.609)	5.0 (.181)	3.0 (.130)	11.00 (.3067)	14.0 (.288)	6.0 (.142)	3.0 (.020)	7.67 (.1500)
Disomidae	Trochochaeta multisetosa										1.0 (.012)		0.33 (.0040)				
Magelonidae	Unknown sp.	1.0 (.010)			0.33 (.0033)												
Maldanidae	Euclymene zonalis	3.0 (.059)	3.0 (.025)	3.0 (.013)	3.00 (.0323)	2.0 (.004)	6.0 (.032)		2.67 (.0120)	4.0 (.020)	2.0 (.020)	4.0 (.018)	3.33 (.0193)	7.0 (.070)	1.0 (.010)	5.0 (.088)	4.33 (.0560)
	Praxillella gracilis	1.0 (.015)	1.0 (.050)		0.67 (.0217)	1.0 (.015)	1.0 (.421)		0.67 (.1453)	1.0 (.024)	2.0 (.795)	1.0 (.240)	1.33 (.3530)	2.0 (.465)	2.0 (.322)	1.0 (.268)	1.67 (.3517)
Opheliidae	Armandia brevis	2.0 (.161)			0.67 (.0537)												
Orbiniidae	Haploscoloplos elongata	1.0 (.023)		5.0 (.038)	2.00 (.0203)	1.0 (.003)	1.0 (.009)		0.67 (.0040)								
	Scoloplos armiger		1.0 (.012)		0.33 (.0040)												
Oweniidae	Myriochele heeri						1.0 (.001)		0.33 (.0003)								
Pectinariidae	Pectinaria californiensis	1.0 (.029)			0.33 (.0097)	1.0 (.018)			0.33 (.0060)					2.0 (.080)	1.0 (.016)		1.0 (.0320)
Spionidae	Laonice cirrata	1.0 (.043)	3.0 (1.048)	2.0 (.150)	2.0 (.4137)	2.0 (.324)	1.0 (.362)	1.0 (.008)	1.33 (.2313)			1.0 (.405)	0.33 (.1350)	2.0 (1.192)	1.0 (.140)		1.0 (.4440)
	Prionospio malmgreni	1.0 (.002)		1.0 (.016)	0.67 (.0060)		1.0 (.004)		0.33 (.0013)			1.0 (.002)	0.33 (.0007)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.	5.0 (.007)		1.0 (.002)	2.00 (.0030)		8.0 (.004)	1.0 (.002)	3.00 (.0020)	1.0 (.002)			0.33 (.0007)				
	Bittium subplanatum		2.0 (.063)	1.0 (.014)	1.00 (.0257)		1.0 (.022)	1.0 (.067)	0.67 (.0297)								
	Mitrella gouldi		3.0 (.076)	1.0 (.035)	1.33 (.0370)	1.0 (.008)	5.0 (.099)	3.0 (.268)	3.00 (.1250)	1.0 (.084)			0.33 (.0280)			1.0 (.029)	0.33 (.0097)
	Oenopota sp.														1.0 (.025)		0.33 (.0083)
	Polinices sp.						1.0 (.670)		0.33 (.2233)								
Opisthobranchia	Odostomia sp.						1.0 (.004)		0.33 (.0013)								
	Turbonilla sp.									2.0 (.026)			0.67 (.0087)				
Pelecypoda (Bivalvia)	Ascila castrensis						1.0 (.260)		0.33 (.0867)	1.0 (.261)		2.0 (.806)	1.0 (.3557)	1.0 (.208)			0.33 (.0693)
	Axinopsida serricata	116.0 (.661)	82.0 (.689)	131.0 (.862)	109.67 (.7373)	91.0 (.716)	99.0 (.333)	73.0 (.270)	87.67 (.4397)	128.0 (1.000)	72.0 (.462)	98.0 (.745)	99.33 (.7357)	74.0 (.532)	163.0 (1.142)	79.0 (.509)	105.33 (.7277)
	Cardiomya oldroydi	1.0 (.003)	2.0 (.005)	2.0 (.007)	1.67 (.0050)					2.0 (.086)			0.67 (.0287)	1.0 (.001)			0.33 (.0003)
	Compsomyax subdiaphana		4.0 (.222)	1.0 (.032)	1.67 (.0847)	1.0 (.064)		2.0 (.118)	1.00 (.0607)	1.0 (.066)	2.0 (5.427)	1.0 (.735)	1.33 (2.0760)		2.0 (.820)		0.67 (.2733)
	Lucinoma annulata					1.0 (.499)			0.33 (.1663)	1.0 (.360)		1.0 (.030)	0.67 (.1300)				
	Macoma alaskansis			2.0 (.344)	0.67 (.1147)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Macoma carlottensis	22.0 (.108)	17.0 (.071)	27.0 (.192)	22.0 (.1237)	21.0 (.324)	28.0 (.329)	7.0 (.057)	18.67 (.2367)	12.0 (.389)	11.0 (.191)	6.0 (.075)	9.67 (.2183)	5.0 (.054)	14.0 (.229)	3.0 (.027)	7.33 (.1033)
	Macoma secta						1.0 (.178)		0.33 (.0593)						1.0 (.174)		0.33 (.0580)
	Megacrenella columbiana	3.0 (.072)		1.0 (.001)	1.33 (.0243)												
	Nemocardium sp.	1.0 (.113)	1.0 (.131)	3.0 (.573)	1.67 (.2723)		2.0 (.173)		0.67 (.0577)	1.0 (.494)	1.0 (.091)		0.67 (.1950)	1.0 (.086)	1.0 (.627)		0.67 (.2377)
	Nucula tenuis	5.0 (.109)	6.0 (.152)	5.0 (.035)	5.33 (.0987)	3.0 (.050)	9.0 (.195)	1.0 (.021)	4.33 (.0887)	1.0 (.017)	1.0 (.042)	1.0 (.004)	1.00 (.0210)		2.0 (.092)	4.0 (.083)	2.0 (.0583)
	Nuculana minuta	7.0 (.224)	6.0 (.221)	9.0 (.372)	7.33 (.2723)	9.0 (.324)	4.0 (.134)	4.0 (.114)	5.67 (.1907)		2.0 (.060)		0.67 (.0200)	2.0 (.020)	2.0 (.033)		1.33 (.0177)
	Pandora filosa		1.0 (.221)		0.33 (.0737)			2.0 (.164)	0.67 (.0547)	1.0 (.068)	1.0 (.093)		0.67 (.0537)				
	Paravalucina tenuisculptis										1.0 (.051)		0.33 (.0170)		1.0 (.317)		0.33 (.1057)

AD-A058 442 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MISS F/G 13/2
AQUATIC DISPOSAL FIELD INVESTIGATIONS, DUWAMISH WATERWAY DISPOS--ETC(U)
JUN 78 R A HARMAN, J C SERWOLD WESRS-76-90
UNCLASSIFIED WES-TR-D-77-24-APP-F NL

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Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

		Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA																	
	Density	4.0	7.0	6.0	5.67	8.0	4.0	1.0	4.33	8.0	8.0	8.0	7.99	6.0	2.0	12.0	6.66
	Biomass	.162	.133	.179	.1579	.319	.114	.005	.1459	.404	2.190	.336	.9764	.217	.150	1.179	.5151
	Number of species	3.0	5.0	5.0	4.33	3.0	2.0	1.0	2.00	4.0	6.0	4.0	4.67	4.0	2.0	6.0	4.00
SEDENTARIA	Density	15.0	18.0	23.0	18.67	16.0	16.0	2.0	11.33	30.0	10.0	10.0	16.65	27.0	11.0	9.0	15.67
	Biomass	.451	1.413	.557	.8070	.526	1.095	.013	.5445	.6530	1.008	.795	.8187	2.095	.630	.376	1.0337
	Number of species	9.0	5.0	5.0	6.33	6.0	7.0	2.0	5.00	3.0	4.0	5.0	4.00	5.0	5.0	3.0	4.33
GASTROPODA	Density	5.0	5.0	3.0	4.33	1.0	16.0	5.0	7.33	4.0			1.33		1.0	1.0	0.67
	Biomass	.007	.139	.051	.0657	.008	.799	.337	.3813	.112			.0373		.025	.029	.0180
	Number of species	1.0	2.0	3.0	2.00	1.0	5.0	3.0	3.00	3.0			1.00		1.0	1.0	0.67
Pelecypoda	Density	155.0	119.0	181.0	151.67	126.0	144.0	89.0	119.67	148.0	91.0	109.0	116.01	84.0	186.0	86.0	118.65
	Biomass	1.290	1.712	2.418	1.8067	1.977	1.602	.744	1.4412	2.741	6.417	2.395	3.8511	.901	3.434	.619	1.6513
	Number of species	7.0	8.0	9.0	8.00	6.0	7.0	6.0	6.33	9.0	8.0	6.0	7.67	6.0	8.0	3.0	5.67
TOTAL	Density	179.0	149.0	213.0	180.34	151.0	180.0	97.0	142.66	190.0	109.0	127.0	141.98	117.0	200.0	108.0	141.65
	Biomass	1.910	3.397	3.205	2.8383	2.830	3.610	1.099	2.5129	3.910	9.615	3.526	5.6835	3.213	4.239	2.203	3.2181
	Number of species	**20.0**	**20.0**	**22.0**	**20.67**	**16.0**	**21.0**	**12.0**	**16.33**	**19.0**	**18.0**	**15.0**	**17.33**	**15.0**	**16.0**	**13.0**	**14.67**

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Replicate and Mean Density and Biomass*

		Station 1,5,9,13,17				Station 2,6,10,14,18			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
TOTAL (TABLE)	Density	682.0	334.0	472.0	495.97	252.0	313.0	179.0	248.01
	Biomass	9.861	6.619	7.869	8.1154	5.019	5.123	2.664	4.2682
	Number of species	58.0	51.0	54.0	54.34	29.0	32.0	32.0	31.01

		Station 3,7,11,15,19				Station 4,8,12,16,20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
TOTAL (TABLE)	Density	289.0	188.0	331.0	269.27	373.0	468.0	526.0	455.58
	Biomass	5.188	10.858	5.523	7.1991	6.848	8.727	7.207	7.8327
	Number of species	32.0	33.0	36.0	33.65	50.0	51.0	51.0	50.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sipuncula	Unknown Sp.										1.0 (.011)		0.33 (.0037)				
Arthropoda Crustacea Malacostraca Amphipoda	Unknown sp.	1.0 (.003)			0.33 (.0010)												

****

Density	1.0			0.33						1.0		0.33				
Biomass	.003			.0010						.011		.0037				
Number of Species	1.0			0.33						1.0		0.33				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5				Station 6				Station 7				Station 8			
		Replicate and Mean Density and Biomass*															
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Nemertea																	
Cerebratulus	Adult sp.			1.0 (.650)	0.33 (.2167)												
	Juvenile sp.													1.0 (.085)	1.0 (.001)	2.0 (.047)	1.33 (.0443)

****

		Station 5				Station 6				Station 7				Station 8			
	Density			1.0	0.33									1.0	1.0	2.0	1.33
	Biomass			.650	.2167									.085	.001	.047	.0443
Number of Species				1.0	0.33									1.0	1.0	1.0	1.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sipuncula	Unknown sp.	1.0 (.128)			0.33 (.0427)												
Nemertea																	
Cerebratulus	Adult sp.	2.0 (.310)	1.0 (.036)	1.0 (.223)	1.33 (.1897)									1.0 (.198)			0.33 (.0660)

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	Density	3.0	1.0	1.0	1.66									1.0			0.33
	Biomass	.438	.036	.223	.2324									.198			.0660
	Number of Speices	2.0	1.0	1.0	1.33									1.0			0.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sipuncula	Unknown sp.			1.0 (.382)	0.33 (.1273)					1.0 (.103)			0.33 (.0343)				
Nemertea																	
Cerebratulus	Adult sp.			1.0 (.132)	0.33 (.0440)	1.0 (.110)	1.0 (.070)		0.67 (.0600)					1.0 (.021)	2.0 (.414)	2.0 (.161)	1.67 (.1987)
Arthropoda																	
Crustacea																	
Malacostraca																	
Amphipoda	Unknown sp.			1.0 (.002)	0.33 (.0007)							1.0 (.001)	0.33 (.0003)			4.0 (.023)	1.33 (.0077)
Tanadacea	Unknown sp.															1.0 (.015)	0.33 (.0050)

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		13-1	13-2	13-3	13-$\bar{x}$	14-1	14-2	14-3	14-$\bar{x}$	15-1	15-2	15-3	15-$\bar{x}$	16-1	16-2	16-3	16-$\bar{x}$
	Density			3.0	0.99	1.0	1.0		0.67	1.0		1.0	0.66	1.0	2.0	7.0	3.33
	Biomass			.516	.1720	.110	.070		.0600	.103		.001	.0346	.021	.414	.199	.2114
Number of	Species			3.0	1.00	1.0	1.0		0.67	1.0		1.0	0.67	1.0	1.0	3.0	1.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 6 April 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Sipuncula	Unknown sp.	2.0 (.015)			0.67 (.0050)												
Nemertea																	
Cerebratulus	Adult sp.	1.0 (.122)	2.0 (.015)		1.00 (.0456)									1.0 (.010)			0.33 (.0033)
	Juveniles	1.0 (.007)			0.33 (.0023)												
Arthropoda																	
Crustacea																	
Amphipoda	Unknown sp.	2.0 (.010)	3.0 (.014)	3.0 (.022)	2.67 (.0153)		2.0 (.008)		0.67 (.0027)						1.0 (.008)	1.0 (.004)	0.67 (.0040)
Tanadacea	Unknown sp.		1.0 (.002)		0.33 (.0007)												
						************											
	Density	6.0	6.0	3.0	5.00		2.0		0.67					1.0	1.0	1.0	1.00
	Biomass	.154	.031	.022	.0689		.008		.0027					.010	.008	.004	.0073
	Number of Species	4.0	3.0	1.0	2.67		1.0		0.33					1.0	1.0	1.0	1.00
						************											
Cumulative	Density	10.0	7.0	8.0	8.32	1.0	3.0		1.34	1.0	1.0	1.0	0.99	4.0	4.0	10.0	5.99
Cumulative	Biomass	.595	.067	1.411	.6910	.110	.078		.0627	.103	.011	.001	.0346	.314	.423	.250	.3290
Cumulative	Number of Species	7.0	4.0	6.0	5.66	1.0	2.0		1.00	1.0	1.0	1.0	1.00	4.0	3.0	5.0	4.00

Field and Laboratory Description of Sediment Grab Sample

Sampled 6 April 1976 , Elliott Bay

	Station 1				Station 2				Station 3				Station 4			
	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Depth	204.0	200.0	202.0	202.00	202.0	200.0	202.0	201.33	216.0	218.0	218.0	217.33	222.0	221.0	222.0	221.67
Sample Volume - Litres	13.0	16.0	13.0	14.00	12.0	11.0	10.0	11.00	6.0	9.0	8.5	7.83	16.0	16.0	16.0	16.00
Sample Residue ml/1	76.9	46.9	30.8	51.53	41.7	36.4	30.0	36.03	66.7	138.9	147.1	117.57	50.0	50.0	62.5	51.17
Percent Rock	0	0	0	0	0	3.2	10.0	4.40	23.9	24.7	0	16.20	0	0	10.0	3.33
Volume Rock ml/1	0	0	0	0	0	1.2	3.0	1.40	23.3	34.4	0	19.23	0	0	6.3	2.10
Percent Wood & Fibers	99.9	99.9	100.0	99.96	98.9	95.0	90.0	94.67	64.8	75.0	99.9	79.99	64.0	52.0	76.5	64.16
Volume Wood & Fibers ml/1	76.9	46.9	30.8	51.53	41.6	34.6	27.0	34.40	43.3	104.4	147.1	98.27	50.0	50.0	56.3	52.10
Percent Wood	24.9	24.9	25.0	24.93	49.8	50.0	50.0	49.93	25.0	42.7	53.2	40.30	60.0	50.0	75.0	61.67
Volume Wood ml/1	19.2	11.7	7.7	12.87	20.8	18.2	15.0	18.00	16.7	59.4	78.3	51.47	30.0	25.0	46.9	33.97
Percent Fibers	75.0	75.0	75.0	75.00	49.8	45.0	40.0	44.93	39.8	32.3	46.7	39.60	4.0	2.0	1.5	2.50
Volume Fibers ml/1	57.7	35.2	23.1	38.67	20.8	16.4	12.0	16.40	26.6	45.0	68.8	46.80	20.0	25.0	9.4	18.13
urficial Layer Thickness		1/8	1/8						¼		1/8					
lor Sediment	b	B/b	B/b		B/b	b	B/b		B/b	b	B/b		b	B/b	b	
S Odor	Yes	No	NO		NO	YES	YES		NO	YES	NO		NO	YES	NO	
sociated Debris																
Oil		X								X	X				X	
Coal																
Seeds																
Metals																
Class																
Brick																
Blue Clay													X			

Field and Laboratory Description of Sediment Grab Sample

Sampled 6 April 1976, Elliott Bay

	Station 5				Station 6				Station 7				Station 8			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
pth	198.0	198.0	200.0	198.67	200.0	200.0	200.0	200.00	202.0	210.0	214.0	208.67	216.0	212.0	216.0	214.67
mple Volume - Litres	7.5	7.0	8.0	7.50	6.5	6.0	5.0	5.83	5.0	6.0	6.0	5.67	15.0	16.0	16.0	15.67
mple Residue ml/l	153.3	64.3	162.5	126.70	153.8	241.7	180.0	191.83	55.0	66.7	108.3	76.67	86.7	121.8	168.8	125.77
ercent Rock	6.9	20.0	1.0	9.33	10.0	0	5.0	5.00	44.9	44.9	0	29.93	7.7	0	3.7	3.80
olume Rock ml/l	10.7	12.9	1.9	8.50	15.4	0	9.0	8.13	24.9	30.0	0	18.30	6.7	0	6.3	4.33
ercent Wood & Fibers	93.0	80.0	98.8	90.60	96.0	99.9	95.0	96.96	55.0	52.0	92.3	66.43	92.2	98.5	96.1	95.60
olume Wood & Fibers ml/l	142.7	51.5	160.6	118.27	138.5	241.7	171.0	183.73	49.6	34.8	100.0	61.47	80.0	120.1	162.5	120.87
rcent Wood	73.0	60.0	66.5	66.50	50.0	83.2	50.0	61.07	45.0	50.0	60.0	51.67	61.1	85.2	75.1	73.80
lume Wood ml/l	112.0	38.6	108.1	86.23	76.9	201.3	90.0	122.73	24.8	33.4	65.0	41.07	53.0	103.8	126.8	94.53
rcent Fibers	20.0	20.0	32.3	24.10	46.0	16.7	45.0	35.90	10.0	2.0	32.3	14.77	31.1	13.3	21.0	21.80
lume Fibers ml/l	30.7	12.9	52.5	32.03	61.6	40.4	81.0	61.00	5.5	1.4	35.0	13.97	27.0	16.3	35.6	26.30
rficial Layer Thickness					1/8	1/8	1/8			1/8	1/8		1/8	1/8	1/8	
lor Sediment	B/b	G/b	G/b		B/b	G/b	G/b		B/b	B/b	B/b		G/b	G/b	G/b	
S Oder	NO	NO	YES		YES	NO	NO		NO	NO	NO		NO	NO	NO	
sociated Debris		X	X											X		
Oil																
Coal																
Seeds	X	X							X							
Metals																
Glass									X							
Brick																
Blue Clay									X							

161

Field and Laboratory Description of Sediment Grab Sample

Sampled 6 April 1976 , Elliott Bay

	Station 9				Station 10				Station 11				Station 12			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
epth	194.0	194.0	194.0	194.00	192.0	194.0	192.0	192.67	206.0	205.0	200.0	208.67	208.0	206.0	206.0	206.67
ample Volume - Litres	7.5	6.0	5.5	6.33	10.0	8.5	8.5	9.00	7.5	10.0	9.5	9.00	8.0	7.5	16.0	10.50
ample Residue ml/l	93.3	183.3	354.5	210.37	95.0	58.8	52.9	68.90	93.3	100.0	105.3	99.53	112.5	393.3	178.1	227.97
ercent Rock	0	5.4	2.5	2.63	10.0	39.9	26.4	25.43	9.9	75.0	30.0	38.30	4.9	0	3.2	2.70
olume Rock ml/l	0	10.0	9.1	6.37	9.5	23.5	26.5	19.83	9.3	75.0	31.0	38.43	5.6	0	5.8	3.80
ercent Wood & Fibers	99.9	98.9	96.3	98.70	90.0	60.0	50.0	66.67	89.9	25.0	69.9	61.26	94.9	99.9	103.0	99.26
olume Wood & Fibers ml/l	93.3	181.6	345.4	206.77	85.5	35.3	26.5	49.1	84.0	25.0	73.7	60.90	106.9	393.3	183.6	227.93
ercent Wood	90.0	84.9	82.5	85.80	80.0	50.0	40.0	56.67	50.0	20.0	69.9	46.63	50.0	49.6	70.1	56.57
olume Wood ml/l	84.0	155.8	292.7	177.50	76.0	29.4	21.2	42.20	46.7	20.0	73.7	46.80	56.3	195.3	125.0	125.53
ercent Fibers	9.9	14.0	14.8	12.90	10.0	10.0	10.0	10.00	39.9	5.0	0	14.97	44.9	50.3	32.9	42.70
olume Fibers ml/l	9.3	25.8	52.7	29.27	9.5	5.9	5.3	6.90	37.3	5.0	0	14.10	50.6	198.0	58.6	102.40
urficial Layer Thickness	1/8	1/8			1/8	1/8	1/8		1/8	1/8	1/8		¼		¼	
olor Sediment	B/b	G/b	G/b		G/b	B/b	B/b		B/b	G/b	G/b		G/b	b	G/b	
S Odor	NO	NO	NO		NO	NO	NO		YES	YES	YES		YES	NO	YES	
ssociated Debris																
Oil			X			X			X	X				X		
Coal																
Seeds										X						
Metals																
Glass										X	X					
Brick																
Blue Clay										X						

Field and Laboratory Description of Sediment Grab Sample

Sampled 6 April 1976 , Elliott Bay

	Station 13				Station 14				Station 15				Station 16			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
epth	176.0	178.0	176.0	176.67	184.0	180.0	180.0	181.33	197.0	186.0	186.0	189.67	198.0	198.0	198.0	198.00
ample Volume - Litres	16.0	16.0	10.5	14.17	9.5	8.0	9.0	8.83	8.5	5.0	11.0	8.17	8.5	16.0	16.0	13.50
ample Residue ml/1	62.5	106.3	64.3	77.70	100.0	193.8	100.0	131.27	188.2	270.0	118.2	158.80	294.1	50.0	100.0	148.03
ercent Rock	4.9	0	0	1.63	0	0	5.0	1.67	2.9	3.7	0	2.20	.7	0	0	.23
olume Rock ml/1	3.1	0	0	1.03	0	0	5.0	1.67	5.6	10.2	0	5.27	2.1	0	0	.70
ercent Wood & Fibers	94.9	99.9	99.9	98.23	100.0	99.9	95.0	99.30	96.0	96.2	99.9	97.66	99.2	100.0	100.0	99.73
olume Wood & Fibers ml/1	59.4	106.3	64.3	76.67	100.0	193.8	95.0	129.60	182.6	259.8	118.2	186.87	292.9	50.0	100.0	147.63
ercent Wood	50.0	48.2	60.0	52.73	70.0	60.0	60.0	63.33	56.2	80.0	64.6	66.93	77.2	50.0	34.4	53.87
olume Wood ml/1	31.3	51.3	38.6	40.40	70.0	116.3	60.0	82.10	105.0	216.0	76.4	132.47	227.1	25.0	34.4	95.50
ercent Fibers	44.9	51.7	39.9	45.50	33.0	39.9	35.0	35.97	40.7	16.2	35.3	30.73	22.0	50.0	65.6	45.87
olume Fibers ml/1	28.1	55.0	25.7	36.27	30.0	77.5	35.0	47.50	76.7	43.8	41.8	54.10	64.9	25.0	65.6	51.83
rficial Layer Thickness			1/8								1/8					
olor Sediment	B/b	B/b	B/b		b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
S Odor	NO	NO	NO		NO	NO	NO		NO	NO	NO		YES	NO	NO	
sociated Debris																
Oil		X				X							X		X	
Coal													X			
Seeds		X				X							X		X	
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 6 April 1976 , Elliott Bay

	Station 17				Station 18				Station 19				Station 20			
	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
epth	150.0	160.0	170.0	160.00	196.0	192.0	210.0	199.33	156.0	158.0	150.0	154.67	162.0	154.0	170.0	162.00
ample Volume - Litres	3.0	[illegible].5	5.0	3.83	10.0	8.0	11.0	9.67	11.0	10.5	4.5	8.67	10.0	9.5	5.0	8.17
mple Residue ml/1	66.7	57.1	40.0	54.60	40.0	56.3	90.9	62.07	54.5	66.9	48.7	56.60	185.0	226.3	160.0	190.43
ercent Rock	94.9	95.0	95.0	94.96	95.0	97.8	89.9	94.23	60.0	97.6	63.2	73.60	90.0	72.8	90.0	84.27
olume Rock ml/1	63.3	54.3	38.0	51.87	38.0	55.1	81.8	58.30	32.7	65.3	30.3	42.77	166.5	164.9	144.0	158.47
ercent Wood & Fibers	4.9	5.0	5.0	4.96	5.0	2.0	10.0	5.68	40.0	2.0	30.1	24.03	10.0	26.1	5.0	13.70
olume Wood & Fibers ml/1	3.3	2.9	2.0	2.73	2.0	1.2	9.1	4.10	21.8	1.4	9.7	10.97	18.5	59.2	8.0	28.57
ercent Wood	4.9	5.0	3.0	4.30	3.0	1.0	0	1.33	20.0	1.0	20.1	13.70	5.0	10.0	5.0	6.67
olume Wood ml/1	3.3	2.0	1.2	2.47	1.2	.6	0	.60	10.9	.7	4.8	5.47	9.2	22.6	8.0	13.27
ercent Fibers	0	0	2.0	.67	2.0	1.0	10.0	4.33	20.0	1.0	10.0	10.33	5.0	16.1	0	7.03
olume Fibers ml/1	0	0	.8	.27	.8	.6	9.1	3.50	10.9	.7	4.9	5.50	9.3	36.6	0	15.30
urficial Layer Thickness		¼	¼				1/8		¼	¼	¼			1/8		
olor Sediment	B/G	B/G	B/G		G/G	G/G	G/G		B/G	B/G	B/G		g/G	B/G	B/G	
S Odor	NO	NO	NO		NO	NO	YES		NO	NO	NO		NO	NO	NO	
ssociated Debris																
Oil							X									
Coal													X	X		
Seeds									X				X	X	X	
Metals															X	
Glass			X										X	X		
Brick																
Blue Clay																

Density of Worm Tubes, Elliott Bay
April 6, 1976

		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF5		3.0		1.00			1.0	0.33								
	MR3									1.0	1.0		0.67				
Sand Tubes	SF9										1.0		0.33				
	SR3										2.0		0.67	1.0			0.33
	SR4						2.0	3.0	1.67					6.0	1.0		2.33
	SR7	29.0	14.0	80.0	41.00			2.0	0.67		66.0	4.0	23.33	12.0	4.0	24.0	13.33
	SR18										1.0		0.33			2.0	0.67
	SC1			3.0	1.00						4.0		1.33		2.0	3.0	1.67
	SC5					1.0			0.33		6.0	1.0	2.33			1.0	0.33
Mucous Membrane Tubes	MM14		8.0		2.67			2.0	0.67					4.0	1.0		1.67

Density of Worm Tubes, Elliott Bay
6 April, 1976

		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1															2.0	0.67
Sand Tubes	SR3														1.0		0.33
	SR7							4.0	1.33					11.0	11.0	2.0	8.00
	SC2			1.0	0.33												
	SC5			1.0	0.33					1.0			0.33		1.0		0.33
Mud Tubes	MM4													1.0	2.0	2.0	1.67

Density of Worm Tubes, Elliott Bay
April 6, 1976

		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sand Tubes	SR4	1.0			0.33									1.0			0.33
	SR7													3.0		1.0	1.33
	SR18			1.0	0.33												
	SC1	2.0	1.0	1.01	1.33						1.0	3.0	1.33			2.0	0.67
	SC5										2.0		0.67				

Density of Worm Tubes, Elliott Bay
April 6, 1976

		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF5			3.0	1.00												
	MF6		1.0	1.0	0.67												
	MR3	5.0		1.0	2.00												
	MR9		1.0	3.0	1.33												
Sand Tubes	SF9					1.0			0.33								
	SR1	4.0	1.0	3.0	2.67										2.0		0.67
	SR2			2.0	0.67												
	SR3							1.0	0.33								
	SR4					8.0			2.67	2.0			0.67	6.0	3.0	1.0	3.33
	SR5	2.0			0.67												
	SR14			1.0	0.67												
	SR10			1.0	0.67							2.0	0.67				
	SC1	19.0	3.0	23.0	15.00	4.0			1.33	2.0			0.67				
	SC2			1.0	0.33		1.0		0.33								
	SC5											2.0	0.67				
Mucous Membrane Tubes	MM4	1.0			0.33											4.0	1.33

Density of Worm Tubes, Elliott Bay
April 6, 1976

		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF6							1.0	0.33	2.0	1.0		1.00				
	MR3	6.0	4.0	2.0	4.00			8.0	2.67	2.0	4.0	9.0	5.00		9.0	2.0	3.67
	MR9													4.0			1.33
Sand Tubes	SF9						3.0	4.0	2.33								
	SR1	240.0	200.0	60.0	166.67	26.0	50.0		25.33								
	SR2	4.0			1.33												
	SR3			1.0	0.33												
	SR4	6.0	2.0	1.0	3.00	3.0	9.0	4.0	5.33	7.0	40.0	7.0	18.0	15.0	4.0	3.0	7.33
	SR5	26.0	11.0	6.0	14.33												
	SR7	110.0	90.0	32.0	77.33	10.0	160.0	17.0	62.33	50.0	50.0	35.0	45.00	27.0	5.0	28.0	20.00
	SR10	55.0	45.0	19.0	39.67	6.0	4.0		3.33		1.0		0.33				
	SR14		1.0	2.0	1.00	1.0			0.33			2.0	0.67				
	SI2					3.0			1.0								
	SC1	11.0	20.0	6.0	12.33	10.0	8.0	6.0	8.00	38.0	15.0	30.0	27.67	19.0	8.0	4.0	10.33
	SC2		1.0	2.0	1.00					7.0	3.0	6.0	5.33	20.0	2.0	3.0	8.33
Mucous Membrane Tubes	MM													1.0	1.0	1.0	1.00
	PC1			3.0	1.0												
	PC2					5.0			1.67			1.0	0.33				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	1.0 (.002)	2.0 (.013)	3.0 (.166)	2.0 (.0603)		2.0 (.044)		0.67 (.0147)	1.0 (.015)	1.0 (.015)	1.0 (.024)	1.0 (.0180)	3.0 (.110)	1.0 (.012)	2.0 (.061)	2.0 (.0610)
Goniadidae	Glycinde armigera											1.0 (.043)	0.33 (.0143)				
	Goniada brunnea	1.0 (.009)			0.33 (.0030)		1.0 (.545)		0.33 (.1817)								
Lumbrineridae	Lumbrineris luti	1.0 (.004)	1.0 (.001)		0.67 (.0017)						1.0 (.017)	1.0 (.009)	0.67 (.0087)		1.0 (.002)	1.0 (.001)	0.67 (.0010)
	Ninoe gemma						1.0 (.036)		0.33 (.0120)								
Nephtyidae	Nephtys ferruginea	3.0 (.009)	2.0 (.015)		1.67 (.0080)	1.0 (.004)			0.33 (.0013)	1.0 (.015)			0.33 (.0050)			1.0 (.003)	0.33 (.0010)
Onuphidae	Onuphis iridescens						1.0 (.049)		0.33 (.0163)			1.0 (.093)	0.33 (.0310)		1.0 (.212)	1.0 (.125)	0.67 (.1123)
Phyllodocidae	Planktonic phyllodocidae					1.0 (.001)			0.33 (.0003)								
Polynoidae	Unknown sp.	1.0 (.027)			0.33 (.0090)												
Sphaerodoridae	Sphaerodoropsis sphaerulifer	1.0 (.005)			0.33 (.0017)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass* Station 1: 1	Station 1: 2	Station 1: 3	Station 1: $\bar{x}$	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: $\bar{x}$	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: $\bar{x}$	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: $\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Heteromastus cf. filobranchus		1.0 (.008)	3.0 (.091)	1.33 (.0330)	3.0 (.044)			1.0 (.0147)			2.0 (.022)	0.67 (.0073)	4.0 (.058)	5.0 (.065)	1.0 (.002)	3.33 (.0417)
Cirratulidae	Chaetozone setosa											1.0 (.001)	0.33 (.0003)	1.0 (.002)			0.33 (.0007)
Maldanidae	Euclymene zonalis	16.0 (.183)	5.0 (.053)	12.0 (.123)	11.0 (.1197)					2.0 (.013)	3.0 (.035)	3.0 (.022)	2.67 (.0233)		2.0 (.010)	2.0 (.017)	1.33 (.0090)
	Praxilella gracilis	1.0 (.021)		1.0 (.172)	0.67 (.0643)	1.0 (.003)			0.33 (.0010)	1.0 (.120)			0.33 (.0400)	1.0 (.240)	2.0 (1.328)	1.0 (.120)	1.33 (.5627)
Opheliidae	Ammotrypane aulogaster		1.0 (.025)		0.33 (.0083)					1.0 (.025)		1.0 (.032)	0.67 (.0190)			1.0 (.031)	0.33 (.0103)
Oweniidae	Owenia fusiformis													1.0 (.025)			0.33 (.0083)
Paraonidae	Aricidea longicornuta	1.0 (.001)			0.33 (.0003)												
Pectinariidae	Pectinaria californiensis	1.0 (.007)			0.33 (.0023)												
Spionidae	Laonice cirrata	1.0 (.145)		2.0 (.118)	1.0 (.0877)	2.0 (.172)			0.67 (.0573)		2.0 (.368)	2.0 (.700)	1.33 (.3560)	2.0 (.700)	3.0 (2.180)	1.0 (.090)	2.0 (.9900)
	Prionospio malmgreni										1.0 (.020)		0.33 (.0067)	1.0 (.012)		1.0 (.010)	0.67 (.0073)
Terebellidae	Terebellidae sp.	3.0 (.060)			1.0 (.0200)												
Trichobranchidae	Trichobranchus glacilis										1.0 (.019)		0.33 (.0063)				

171

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastronoda																	
Prosobranchia	Barleeia sp.	1.0 (.001)			0.33 (.0003)	1.0 (.001)			0.33 (.0003)			4.0 (.016)	1.33 (.0053)				
	Mitrella gouldi		3.0 (.235)		1.0 (.0783)											1.0 (.126)	0.33 (.0420)
	Odostomia sp.	1.0 (.003)			0.33 (.0010)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Axinopsida serricata	176.0 (.487)	90.0 (.351)	109.0 (.257)	125.0 (.3650)	86.0 (.361)	22.0 (.050)		36.0 (.1370)	101.0 (.521)	41.0 (.216)	55.0 (.422)	65.67 (.3863)	54.0 (.402)	75.0 (.540)	59.0 (.409)	62.67 (.4503)
	Cardiomya oldroydi	1.0 (.010)			0.33 (.0033)												
	Macoma alaskansis										1.0 (.123)		0.33 (.0410)				
	M. carlottensis	26.0 (.167)	17.0 (.368)	14.0 (.360)	19.0 (.2983)	16.0 (.264)			5.33 (.0880)	17.0 (.238)	10.0 (.359)	5.0 (.157)	10.67 (.2513)	12.0 (.085)	9.0 (.209)	9.0 (.130)	10.0 (.1413)
	Megacrenella columbiana											1.0 (.131)	0.33 (.0437)				
	Nucula tenuis			2.0 (.008)	0.67 (.0027)					1.0 (.005)		1.0 (.083)	0.67 (.0293)	1.0 (.077)	2.0 (.022)	2.0 (.022)	1.67 (.0403)
	Nuculana minuta	1.0 (.060)	1.0 (.030)	1.0 (.001)	1.0 (.0303)	3.0 (.021)			1.0 (.0070)	8.0 (.468)	3.0 (.078)	2.0 (.041)	4.33 (.1957)	2.0 (.035)	2.0 (.060)		1.33 (.0317)
	Pandora filosa											1.0 (.010)	0.33 (.0033)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

		Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	8.0	5.0	3.0	5.33	4.0	3.0		2.32	2.0	2.0	4.0	2.66	3.0	3.0	5.0	3.67
	Biomass	.056	.146	.166	.0837	.049	.630		.2263	.030	.032	.169	.0770	.110	.226	.190	.1753
	Number of species	6.0	3.0	1.0	3.33	3.0	3.0		2.0	2.0	2.0	4.0	2.67	1.0	3.0	4.0	2.67
SEDENTARIA	Density	23.0	7.0	18.0	15.99	6.0			2.0	4.0	7.0	9.0	6.66	10.0	12.0	7.0	9.65
	Biomass	.417	.086	.504	.3356	.219			.0730	.158	.442	.777	.4589	1.037	3.583	.270	1.6300
	Number of species	6.0	3.0	4.0	4.33	3.0			1.0	3.0	4.0	5.0	4.0	6.0	4.0	6.0	5.33
GASTROPODA	Density	2.0	3.0		1.66	1.0			0.33			4.0	1.33			1.0	0.33
	Biomass	.004	.235		.0796	.001			.0003			.016	.0053			.126	.0420
	Number of species	2.0	1.0		1.00	1.0			0.33			1.0	0.33			1.0	0.33
Pelecypoda	Density	204.0	108.0	126.0	146.0	105.0	22.0		42.33	127.0	55.0	65.0	82.33	69.0	88.0	70.0	75.67
	Biomass	.724	.749	.626	.6996	.646	.050		.2320	1.232	.776	.844	.9506	.599	.831	.561	.6636
	Number of species	4.0	3.0	4.0	3.67	3.0	1.0		1.33	4.0	4.0	6.0	4.67	4.0	4.0	3.0	3.67
TOTAL	Density	237.0	123.0	147.0	168.98	116.0	25.0		46.98	133.0	64.0	82.0	92.98	82.0	103.0	83.0	89.32
	Biomass	1.2010	1.102	1.296	1.1985	.9150	.6800		.5316	1.420	1.250	1.806	1.4918	1.746	4.640	1.147	2.5199
	Number of species	18.0	10.0	9.0	12.33	10.0	4.0		4.67	9.0	10.0	16.0	11.67	11.0	11.0	14.0	12.00

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5: 1	Station 5: 2	Station 5: 3	Station 5: $\bar{x}$	Station 6: 1	Station 6: 2	Station 6: 3	Station 6: $\bar{x}$	Station 7: 1	Station 7: 2	Station 7: 3	Station 7: $\bar{x}$	Station 8: 1	Station 8: 2	Station 8: 3	Station 8: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*					1.0 (.068)			0.33 (.0227)					2.0 (.020)		1.0 (.011)	1.0 (.0103)
Goniadidae	*Goniada brunnea*					1.0 (.002)			0.33 (.0007)						2.0 (.223)		0.67 (.0743)
Lumbrineridae	*Lumbrineris bicirrata*						1.0 (.807)		0.33 (.2690)					1.0 (.223)			0.33 (.0743)
	Lumbrineris luti			1.0 (.002)	0.33 (.0007)						1.0 (.002)		0.33 (.0007)	1.0 (.003)	1.0 (.010)		0.67 (.0043)
Nephtyidae	*Nephtys ferruginea*			1.0 (.028)	0.33 (.0093)	2.0 (.003)	1.0 (.012)		1.0 (.0050)		1.0 (.172)	1.0 (.001)	0.67 (.0577)	2.0 (.025)	3.0 (.062)	1.0 (.002)	2.0 (.0297)
Neridae	*Nereis procera*			1.0 (.021)	0.33 (.0070)												
Onuphidae	*Onuphis iridescens*			1.0 (.071)	0.33 (.0237)		1.0 (.123)		0.33 (.0410)	1.0 (.025)			0.33 (.0083)	1.0 (.168)	1.0 (.184)	1.0 (.088)	1.0 (.1467)
Phyllodocidae	*Phyllodoce groenlandica*														1.0 (.002)		0.33 (.0007)
	Phyllodoce williamsi														1.0 (.002)		0.33 (.0007)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Sedentaria																	
Capitellidae	Heteromastus cf. filobranchus	1.0 (.029)		7.0 (.040)	2.67 (.0230)	5.0 (.084)	4.0 (.043)		3.0 (.0440)	1.0 (.035)		2.0 (.028)	1.0 (.0210)	5.0 (.038)	11.0 (.110)		5.33 (.0493)
Maldanidae	Euclymene zonalis			7.0 (.045)	2.33 (.0150)	12.0 (.075)	13.0 (.104)		8.33 (.0597)					8.0 (.068)	1.0 (.002)	3.0 (.042)	4.0 (.0373)
	Praxilella gracilis	1.0 (.049)			0.33 (.0163)	1.0 (.008)	1.0 (.027)		0.67 (.0117)					2.0 (.950)	2.0 (.701)	1.0 (.080)	1.67 (.5770)
Spionidae	Laonice cirrata					2.0 (.198)			0.67 (.0660)	1.0 (.034)			0.33 (.0113)			1.0 (.538)	0.33 (.1793)
Mollusca																	
Gastropoda																	
Opistnobranchia	Turbonilla sp.														1.0 (.003)	1.0 (.050)	1.0 (.0193)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Opisthobranchia	*Turbonilla* sp.														1.0 (.008)	1.0 (.050)	0.33 (.0193)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Pelecypoda (Bivalvia)	Axinopsida serricata			7.0 (.065)	2.33 (.0217)	27.0 (.204)	26.0 (.103)		17.67 (.1023)					20.0 (.061)	1.0 (.002)	28.0 (.185)	16.33 (.0827)
	Macoma carlottensis	1.0 (.009)		2.0 (.053)	1.0 (.0207)	5.0 (.052)	3.0 (.026)		2.67 (.0260)		1.0 (.001)		0.33 (.0003)	8.0 (.243)	7.0 (.033)	13.0 (.270)	9.33 (.1820)
	M. alaskansis			1.0 (.577)	0.33 (.1923)			1.0 (.142)	0.33 (.0473)								
	Nucula tenuis			1.0 (.031)	0.33 (.0103)									1.0 (.002)		2.0 (.105)	1.0 (.0357)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

		Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density			4.0	1.32	4.0	3.0		2.32	1.0	2.0	1.0	1.33	7.0	9.0	3.0	6.33
	Biomass			.122	.0407	.073	.942		.3384	.025	.174	.001	.0667	.439	.483	.101	.3410
	Number of species			4.0	1.33	3.0	3.0		2.0	1.0	2.0	1.0	1.33	5.0	6.0	3.0	4.67
SEDENTARIA	Density	2.0		14.0	5.33	20.0	18.0		12.67	2.0		2.0	1.33	15.0	14.0	5.0	11.33
	Biomass	.078		.085	.0543	.365	.179		.1814	.069		.028	.0323	1.056	.813	.660	.8429
	Number of species	2.0		2.0	1.33	4.0	3.0		2.33	2.0		1.0	1.0	3.0	3.0	3.0	3.0
GASTROPODA	Density														1.0	1.0	0.67
	Biomass														.008	.050	.0193
	Number of species														1.0	1.0	0.67
Pelecypoda	Density	1.0		11.0	3.99	32.0	29.0	1.0	20.67		1.0		0.33	29.0	8.0	43.0	26.67
	Biomass	.009		.726	.2450	.256	.129	.142	.1756		.001		.0003	.306	.035	.560	.3004
	Number of species	1.0		4.0	1.67	2.0	2.0	1.0	1.67		1.0		0.33	3.0	2.0	3.0	2.67
TOTAL	Density	3.0		29.0	10.64	56.0	50.0	1.0	35.66	3.0	3.0	3.0	2.99	51.0	32.0	52.0	45.0
	Biomass	.087		.933	.3400	.694	1.250	.142	.6954	.094	.175	.029	.0993	1.801	1.339	1.371	1.5036
	Number of species	3.0		10.0	4.33	9.0	8.0	1.0	6.0	3.0	3.0	2.0	2.66	11.0	12.0	10.0	11.01

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 9: 1	Station 9: 2	Station 9: 3	Station 9: $\bar{x}$	Station 10: 1	Station 10: 2	Station 10: 3	Station 10: $\bar{x}$	Station 11: 1	Station 11: 2	Station 11: 3	Station 11: $\bar{x}$	Station 12: 1	Station 12: 2	Station 12: 3	Station 12: $\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*													1.0 (.017)	1.0 (.010)		0.67 (.0090)
Goniadidae	*Goniada brunnea*			1.0 (.350)	0.33 (.1167)												
Lumbrineridae	*Lumbrineris luti*			1.0 (.004)	0.33 (.0013)		1.0 (.002)		0.33 (.0007)						2.0 (.006)	1.0 (.002)	1.0 (.0027)
Nephtyidae	*Nephtys ferruginea*	1.0 (.002)			0.33 (.0007)										1.0 (.006)		0.33 (.0020)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Sedentaria																	
Capitellidae cf.	*Heteromastus filobranchus*	2.0 (.024)		2.0 (.025)	1.33 (.0163)									3.0 (.023)	4.0 (.025)		2.33 (.0160)
	Capitella capitata						1.0 (.010)		0.33 (.0033)								
Disomidae	*Trochochaeta mutisetosa*															1.0 (.003)	0.33 (.0010)
Maldanidae	*Euclymene zonalis*													1.0 (.003)	2.0 (.030)	1.0 (.001)	1.33 (.0113)
Paraonidae	*Paraonella spinifera*														1.0 (.001)	1.0 (.001)	0.67 (.0007)
Pectinariidae	*Pectinaria californiensis*	1.0 (.015)			0.33 (.0050)									1.0 (.005)	1.0 (.013)	1.0 (.035)	1.0 (.0177)
Mollusca																	
Gastropoda																	
Prosobranchia	*Polinices sp.*														1.0 (.722)		0.33 (.2407)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Pelecypoda (Bivalvia)	*Axinopsida serricata*	6.0 (.027)			2.0 (.0090)									81.0 (.233)	7.0 (.026)	1.0 (.002)	29.67 (.0870)
	Macoma carlottensis	1.0 (.005)	1.0 (.005)		0.67 (.0033)		1.0 (.001)		0.33 (.0003)					15.0 (.208)	4.0 (.087)	3.0 (.078)	7.33 (.1243)
	Mytilus edulis			1.0 (.041)	0.33 (.0137)												
	Nucula tenuis													2.0 (.027)			0.67 (.0090)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

		Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	1.0		2.0	0.99		1.0		0.33					1.0	4.0	1.0	2.00
	Biomass	.002		.354	.1187		.002		.0007					.017	.022	.002	.0137
	Number of species	1.0		2.0	1.0		1.0		0.33					1.0	3.0	1.0	1.67
SEDENTARIA	Density	3.0		2.0	1.67		1.0		0.33					5.0	8.0	4.0	5.66
	Biomass	.039		.025	.0213		.010		.0033					.031	.069	.040	.0467
	Number of species	2.0		1.0	1.0		1.0		0.33					3.0	4.0	4.0	3.67
GASTROPODA	Density														1.0		0.33
	Biomass														.722		.2407
	Number of species														1.0		0.33
Pelecypoda	Density	7.0	1.0	1.0	3.0		1.0		0.33					98.0	11.0	4.0	37.67
	Biomass	.032	.005	.041	.0260		.001		.0003					.468	.113	.080	.2203
	Number of species	2.0	1.0	1.0	1.33		1.0		0.33					3.0	2.0	2.0	2.33
TOTAL	Density	11.0	1.0	5.0	5.66		3.0		0.99					104.0	23.0	9.0	45.33
	Biomass	.0730	.005	.420	.1660		.0130		.0043					.516	.926	.122	.5214
	Number of species	5.0	1.0	4.0	3.33		3.0		0.99					7.0	10.0	7.0	8.0

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*	1.0 (.010)	1.0 (.052)		0.67 (.0207)	1.0 (.010)	2.0 (.107)	1.0 (.025)	1.33 (.0473)						2.0 (.061)		0.67 (.0203)
Lumbrineridae	*Lumbrineris luti*		1.0 (.001)		0.33 (.0003)	1.0 (.003)	1.0 (.004)	1.0 (.002)	1.0 (.0030)		1.0 (.003)		0.33 (.0010)		1.0 (.018)		0.33 (.0060)
Nephtyidae	*Nephtys ferruginea*		1.0 (.005)	2.0 (.038)	1.0 (.0143)	1.0 (.003)	1.0 (.025)	2.0 (.010)	1.33 (.0127)	3.0 (.017)	1.0 (.002)		1.33 (.0063)		1.0 (.001)		0.33 (.0003)
Onuphidae	*Onuphis iridescens*	1.0 (.014)			0.33 (.0047)		1.0 (.036)		0.33 (.0120)		1.0 (.082)		0.33 (.0273)		1.0 (.044)		0.33 (.0147)
Phyllodocidae	*Phyllodocidae groenlandica*	1.0 (.038)			0.33 (.0127)												

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Sedentaria																	
Abericolidae	Abarenicola pacifica									1.0 (.110)			0.33 (.0367)				
Capitellidae	cf. Heteromastus filobranchus	2.0 (.020)	2.0 (.003)		1.33 (.0077)	2.0 (.010)	4.0 (.056)	2.0 (.048)	2.67 (.0380)	4.0 (.041)	2.0 (.028)	1.0 (.004)	2.33 (.0243)	1.0 (.002)	3.0 (.072)		1.33 (.0247)
Cirratulidae	Chaetozone setosa									1.0 (.012)	1.0 (.023)		0.67 (.0117)				
Maldanidae	Euclymene zonalis													1.0 (.002)	2.0 (.018)		1.0 (.0067)
	Praxilella gracilis			1.0 (.005)	0.33 (.0017)		1.0 (.465)	1.0 (.378)	0.67 (.2810)		1.0 (.270)		0.33 (.0900)			1.0 (.064)	0.33 (.0213)
Oweniidae	Myriochele heeri						1.0 (.008)		0.33 (.0027)								
Pectinariidae	Pectinaria californiensis	1.0 (.050)			0.33 (.0167)		1.0 (.048)		0.33 (.0160)								
Spionidae	Laonice cirrata	1.0 (.205)		1.0 (.034)	0.67 (.0797)	1.0 (.005)			0.33 (.0017)								
	Prionospio malmgreni					1.0 (.002)	1.0 (.002)		0.67 (.0013)								
Trichobranchidae	Trichobranchus glacialis							1.0 (.003)	0.33 (.0010)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Oenopota							1.0 (.025)	0.33 (.0083)								
	Polinices sp.		1.0 (3.132)		0.33 (1.0440)							1.0 (.036)	0.33 (.0120)				
Opisthobranchia	Turbonilla sp.										1.0 (.149)		0.33 (.0497)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Axinopsida serricata	32.0 (.241)	63.0 (.333)	34.0 (.262)	43.0 (.2787)	25.0 (.101)	74.0 (.358)	20.0 (.124)	39.67 (.1943)	7.0 (.026)	36.0 (.177)	6.0 (.012)	16.33 (.0717)	43.0 (.114)	86.0 (.416)	111.0 (.540)	80.0 (.3567)
	Cardiomya oldroydi	1.0 (.010)	1.0 (.001)	1.0 (.026)	1.0 (.0123)												
	Macoma carlottensis	13.0 (.182)	12.0 (.188)	10.0 (.119)	11.67 (.1630)	5.0 (.110)	24.0 (.322)	10.0 (.166)	13.0 (.1993)	5.0 (.010)	5.0 (.105)	3.0 (.021)	4.33 (.0453)	4.0 (.069)	22.0 (.239)	8.0 (.063)	11.33 (.1237)
	Macoma alaskansis						3.0 (.623)	1.0 (1.164)	1.33 (.5957)								
	Macoma secta					1.0 (.098)			0.33 (.0327)		1.0 (.133)		0.33 (.0443)				
	Nemocardium sp.		1.0 (.073)		0.33 (.0577)												
	Nucula tenuis						2.0 (.540)		0.67 (.1800)						1.0 (.072)		0.33 (.0240)
	Nuculana minuta	6.0 (.129)	7.0 (.247)	3.0 (.074)	5.33 (.1500)	1.0 (.015)	2.0 (.133)	1.0 (.017)	1.33 (.0550)		10.0 (.479)		3.33 (.1597)	2.0 (.052)	1.0 (.013)	1.0 (.028)	1.33 (.0310)

157-187

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

		Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	3.0	3.0	2.0	2.66	3.0	5.0	4.0	3.99	3.0	3.0		1.99		5.0		1.66
	Biomass	.062	.058	.038	.0527	.016	.172	.037	.0750	.017	.087		.0346		.124		.0413
	Number of species	3.0	3.0	1.0	2.33	3.0	4.0	3.0	3.33	1.0	3.0		1.33		4.0		1.33
SEDENTARIA	Density	4.0	2.0	2.0	2.66	4.0	8.0	4.0	5.33	6.0	4.0	1.0	3.66	2.0	5.0	1.0	2.66
	Biomass	.275	.003	.039	.1058	.017	.579	.429	.3417	.163	.321	.004	.1627	.004	.090	.064	.0527
	Number of species	3.0	1.0	2.0	2.0	3.0	5.0	3.0	3.67	3.0	3.0	1.0	2.33	2.0	2.0	1.0	1.67
GASTROPODA	Density		1.0		0.33			1.0	0.33		1.0	1.0	0.67				
	Biomass		3.132		1.0440			.025	.0083		.149	.036	.0617				
	Number of species		1.0		0.33			1.0	0.33		1.0	1.0	0.67				
Pelecypoda	Density	52.0	84.0	48.0	61.33	32.0	105.0	32.0	56.33	12.0	52.0	9.0	24.33	49.0	110.0	120.0	92.99
	Biomass	.562	.942	.481	.6617	.324	1.976	1.471	1.2570	.036	.894	.033	.3210	.235	.740	.631	.5354
	Number of species	4.0	5.0	4.0	4.33	4.0	5.0	4.0	4.33	2.0	4.0	2.0	2.67	3.0	4.0	3.0	3.33
TOTAL	Density	59.0	90.0	52.0	66.98	39.0	118.0	41.0	65.98	21.0	60.0	11.0	30.65	51.0	120.0	121.0	97.32
	Biomass	.899	4.135	.558	1.8642	.357	2.727	1.962	1.682	.216	1.451	.073	.5800	.239	.954	.695	.6294
	Number of species	10.0	10.0	7.0	8.99	10.0	14.0	11.0	11.66	6.0	11.0	4.0	7.0	5.0	10.0	4.0	6.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	Station 17: 2	Station 17: 3	Station 17: $\bar{x}$	Station 18: 1	Station 18: 2	Station 18: 3	Station 18: $\bar{x}$	Station 19: 1	Station 19: 2	Station 19: 3	Station 19: $\bar{x}$	Station 20: 1	Station 20: 2	Station 20: 3	Station 20: $\bar{x}$
nnelida																	
Polychaeta																	
Errantia																	
Arabellidae	Notocirrus californiensis						1.0 (.110)		0.33 (.0367)	1.0 (.018)			0.33 (.0060)				
Glyceridae	Glycera capitata	1.0 (.035)		2.0 (.038)	1.0 (.0243)		2.0 (.120)	3.0 (.080)	1.67 (.0667)					3.0 (.260)		1.0 (.010)	1.33 (.0900)
Goniadidae	Glycinde armigera	1.0 (.015)		2.0 (.008)	1.0 (.0077)						2.0 (.019)		0.67 (.0063)			2.0 (.150)	0.67 (.0050)
Lumbrineridae	Lumbrineris luti	4.0 (.018)		1.0 (.005)	1.67 (.0077)			2.0 (.004)	0.67 (.0013)								
Nephtyidae	Nephtys ferruginea		1.0 (.008)	4.0 (.048)	1.67 (.0187)		2.0 (.049)	1.0 (.002)	1.0 (.0170)					1.0 (.003)			0.33 (.001)
Onuphidae	Onuphis iridescens	2.0 (.080)	1.0 (.020)	1.0 (.035)	1.33 (.0450)	1.0 (.038)	1.0 (.033)	1.0 (.012)	1.0 (.0277)	1.0 (.024)	1.0 (.001)	1.0 (.038)	1.0 (.0210)	2.0 (.095)		1.0 (.026)	1.0 (.0403)
Phyllodocidae	Eteone sp.						1.0 (.002)		0.33 (.0007)								
	Phyllodoce groenlandica					1.0 (.080)			0.33 (.0267)								
	Planktonic phyllodocidae					1.0 (.011)			0.33 (.0037)								
Syllidae	Unknown sp.			1.0 (.002)	0.33 (.0007)	1.0 (.001)			0.33 (.0003)								

Column group heading: Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polycnaeta																	
Sedentaria																	
Capitellidae	cf. Heteromastus filobranchus	2.0 (.021)	2.0 (.045)	4.0 (.125)	2.67 (.0637)	1.0 (.012)	3.0 (.048)	9.0 (.180)	4.33 (.0800)	4.0 (.026)	2.0 (.010)		2.0 (.0120)	18.0 (.222)	1.0 (.002)	5.0 (.076)	8.0 (.1000)
Cirratulidae	Chaetozone setosa	1.0 (.003)			0.33 (.0010)												
Maldanidae	Euclymene zonalis	5.0 (.040)		1.0 (.006)	2.0 (.0153)	1.0 (.005)	3.0 (.042)	4.0 (.041)	2.67 (.0293)	2.0 (.015)	2.0 (.010)	2.0 (.022)	2.0 (.0157)		4.0 (.028)		1.33 (.0093)
	Praxillella gracilis			2.0 (.045)	0.67 (.0150)			1.0 (.207)	0.33 (.0690)	1.0 (.398)		1.0 (.010)	0.67 (.1360)				
Orbiniidae	Scoloplos armiger	1.0 (.002)		1.0 (.013)	0.67 (.0050)												
Oweniidae	Myriochele heeri		1.0 (.003)		0.33 (.0010)		1.0 (.003)		0.33 (.0010)								
	Owenia fusiformis					1.0 (.010)			0.33 (.0033)								
Spionidae	Laonice cirrata	1.0 (.201)			0.33 (.0670)			1.0 (.620)	0.33 (.2067)	2.0 (.577)	1.0 (.300)	1.0 (.210)	1.33 (.3623)	2.0 (.550)			0.67 (.1833)
	Prionospio pinnata							1.0 (.011)	0.33 (.0037)								
Trichobranchidae	Pista cristata			1.0 (.015)	0.33 (.0050)		1.0 (.115)	1.0 (.010)	0.67 (.0417)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 17: 1	Station 17: 2	Station 17: 3	Station 17: x̄	Station 18: 1	Station 18: 2	Station 18: 3	Station 18: x̄	Station 19: 1	Station 19: 2	Station 19: 3	Station 19: x̄	Station 20: 1	Station 20: 2	Station 20: 3	Station 20: x̄
Mollusca																	
Gastropoda																	
Prosobranchia	*Barleeia* sp.		2.0 (.006)	6.0 (.009)	2.67 (.0050)		9.0 (.014)		3.0 (.0047)		3.0 (.006)		1.0 (.0020)			1.0 (.005)	0.33 (.0017)
	Bittium subplanatum			4.0 (.104)	1.33 (.0347)												
	Mitrella gouldi	1.0 (.061)		3.0 (.042)	1.33 (.0343)		1.0 (.073)	1.0 (.075)	0.67 (.0493)	1.0 (.020)			0.33 (.0067)		2.0 (.109)	1.0 (.087)	1.0 (.0653)
	Oenopota sp.	1.0 (.067)			0.33 (.0223)					1.0 (.092)			0.33 (.0307)			1.0 (.015)	0.33 (.0050)
	Polinices sp.			1.0 (.480)	0.33 (.1600)												

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Mollusca Pelecypoda (Bivalvia)	Ascila castrensis										2.0 (1.084)		0.67 (.3613)				
	Axinopsida serricata	87.0 (.579)	130.0 (.509)	152.0 (.805)	123.0 (.6310)	68.0 (.241)	169.0 (.593)	174.0 (.696)	137.0 (.5100)	76.0 (.386)	38.0 (.196)	44.0 (.286)	53.67 (.2893)	96.0 (.411)	106.0 (.410)	80.0 (.373)	94.0 (.3980)
	Cardiomya oldroydi		4.0 (.037)	1.0 (.010)	1.67 (.0157)	4.0 (.050)	1.0 (.004)		1.67 (.0180)	1.0 (.047)			0.33 (.0157)	1.0 (.020)	2.0 (.141)		1.0 (.0537)
	Kurtziella plumba											1.0 (.020)	0.33 (.0067)				
	Lucinoma annulata									1.0 (.084)	1.0 (.204)		0.67 (.0960)	1.0 (.003)			0.33 (.0010)
	Lysonia californica	1.0 (.020)			0.33 (.0067)												
	Macoma carlottensis	10.0 (.170)		43.0 (.143)	17.67 (.1043)	6.0 (.111)	21.0 (.269)	19.0 (.120)	15.33 (.1667)	6.0 (.041)	6.0 (.075)	2.0 (.155)	4.67 (.0903)	3.0 (.079)	5.0 (.020)	1.0 (.016)	3.0 (.0383)
	Macoma alaskensis	1.0 (1.446)			0.33 (.4820)												
	Macoma secta			4.0 (.750)	1.33 (.2500)		1.0 (.218)	2.0 (.120)	1.0 (.1127)								
	Megacrenella columbiana	1.0 (.009)			0.33 (.0030)		1.0 (.186)		0.33 (.0620)								
	Nemocardium sp.	2.0 (.222)	1.0 (.069)	2.0 (.039)	1.67 (.1100)	1.0 (.063)		2.0 (.725)	1.0 (.2627)								
	Nucula tenuis	3.0 (.026)	7.0 (.066)	5.0 (.090)	5.0 (.0607)	5.0 (.078)	11.0 (.456)	6.0 (.066)	7.33 (.2000)						1.0 (.005)	1.0 (.063)	0.67 (.0227)
	Nuculana minuta	11.0 (.560)	12.0 (.759)	9.0 (.251)	10.67 (.5233)	16.0 (.656)	6.0 (.367)	5.0 (.105)	9.0 (.3760)	1.0 (.021)		3.0 (.245)	1.33 (.0887)				

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

		Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	8.0	2.0	11.0	7.0	4.0	7.0	7.0	5.99	2.0	3.0	1.0	2.0	6.0		4.0	3.33
	Biomass	.148	.028	.136	.1041	.130	.314	.098	.1808	.042	.020	.038	.0333	.358		.186	.1813
	Number of species	4.0	2.0	6.0	4.0	4.0	5.0	4.0	4.33	2.0	2.0	1.0	1.67	3.0		3.0	2.0
SEDENTARIA	Density	10.0	3.0	9.0	7.33	3.0	8.0	17.0	9.32	9.0	5.0	4.0	6.00	20.0	5.0	5.0	10.0
	Biomass		.048	.204	.1730	.027	.208	1.069	.4347	1.016	.320	.242	.5260	.772	.030	.076	.2926
	Number of species	5.0	2.0	5.0	4.00	3.0	4.0	6.0	4.33	4.0	3.0	3.0	3.33	2.0	2.0	1.0	1.67
GASTROPODA	Density	2.0	2.0	14.0	5.99		10.0	1.0	3.67	2.0	3.0		1.67		2.0	3.0	1.66
	Biomass	.128	.006	.635	.2563		.087	.075	.0540	.112	.006		.0394		.109	.107	.0720
	Number of species	2.0	1.0	4.0	2.33		2.0	1.0	1.0	2.0	1.0		1.0		1.0	3.0	1.33
Pelecypoda	Density	116.0	154.0	216.0	162.0	100.0	210.0	208.0	172.66	85.0	47.0	50.0	60.67	101.0	114.0	82.0	99.0
	Biomass	3.032	1.440	2.088	2.1867	1.199	2.093	1.832	1.7081	.579	1.559	.706	.9480	.513	.576	.452	.5137
	Number of species	8.0	5.0	7.0	6.67	6.0	7.0	6.0	6.33	5.0	4.0	4.0	4.33	4.0	4.0	3.0	3.67
TOTAL	Density	136.0	161.0	250.0	182.32	107.0	235.0	233.0	191.64	98.0	58.0	55.0	70.34	127.0	121.0	94.0	114.0
	Biomass	3.575	1.522	3.063	2.7201	1.356	2.702	3.074	2.3776	1.749	1.905	.9860	1.5467	1.643	.715	.821	1.0597
	Number of species	19.0	10.0	22.0	17.00	13.0	18.0	17.0	15.99	13.0	10.0	8.0	10.33	9.0	7.0	10.0	8.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

		Replicate and Mean Density and Biomass*															
		Station 1,5,9,13,17				Station 2,6,10,14,18				Station 3,7,11,15,19				Station 4,8,12,16,20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density																
	Biomass																
	Number of species																
SEDENTARIA	Density																
	Biomass																
	Number of species																
GASTROPODA	Density																
	Biomass																
	Number of species																
Pelecypoda	Density																
	Biomass																
	Number of species																
TOTAL	Density	446.0	375.0	483.0	434.58	318.0	431.0	275.0	340.59	255.0	185.0	151.0	196.96	415.0	399.0	359.0	391.30
	Biomass	5.832	6.764	6.270	6.2888	3.322	7.372	5.178	5.2908	3.479	4.781	2.894	3.7178	5.9450	8.574	4.156	6.2340
	Number of species	55.0	31.0	52.0	45.98	43.0	47.0	29.0	39.31	28.00	34.0	29.0	31.66	43.00	50.0	45.0	46.01

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum Class Subclass Order Family	Scientific Name	Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta	Unknown fragments		1.0 (.002)		0.33 (.0007)		1.0 (.124)		0.33 (.0413)	1.0 (.030)	1.0 (.012)		0.67 (.0140)				
Sipuncula	Unknown sp.	1.0 (.010)	2.0 (.076)		1.0 (.0287)		1.0 (.098)		0.33 (.0327)	1.0 (.133)			0.33 (.0443)				
Nemertea																	
Cerebratulus	Adult sp.			1.0 (.148)	0.33 (.0493)												
	Juvenile sp.						2.0 (.004)		0.67 (.0013)					1.0 (.013)			0.33 (.0043)
Arthropoda Crustacea Malacostraca Amphipoda	Unknown sp.	4.0 (.010)	4.0 (.012)	1.0 (.003)	3.0 (.0083)	1.0 (.003)			0.33 (.0010)							1.0 (.002)	0.33 (.0007)

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	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Density	5.0	7.0	2.0	4.66	1.0	4.0		1.67	2.0	1.0		1.0	1.0		1.0	0.66
Biomass	.020	.090	.151	.0870	.003	.226		.0763	.163	.012		.0583	.013		.002	.0050
Number of Species	2.0	3.0	2.0	2.33	1.0	3.0		1.33	2.0	1.0		1.0	1.0		1.0	0.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta	Unknown fragments			1.0 (.029)	0.33 (.0097)			1.0 (.003)	0.33 (.0010)								
Sipuncula			1.0 (.014)		0.33 (.0047)												
Nemertea																	
Cerebratulus	Adult sp.					3.0 (.213)			1.0 (.0710)	2.0 (.102)			0.67 (.0340)				
Arthropoda																	
Crustacea																	
Malacostraca																	
Decapoda	Unknown sp. (crab)														1.0 (.006)		0.33 (.0020)
Amphipoda	Unknown sp.											1.0 (.008)	0.33 (.0027)				
	*************																
	Density		1.0	1.0	0.66	3.0		1.0	1.33	2.0		1.0	1.33		1.0		0.33
	Biomass		.014	.029	.0144	.213		.003	.0720	.102		.008	.0367		.006		.0020
Number of Species			1.0	1.0	0.67	1.0		1.0	0.67	1.0		1.0	0.67		1.0		0.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta	Unknown fragments	1.0 (.003)			0.33 (.0010)										1.0 (.050)	1.0 (.028)	0.67 (.0260)
Nemertea																	
Cerebratulus	Adult sp.	1.0 (.038)			0.33 (.0127)												
	Juvenile sp.			1.0 (.008)	0.33 (.0027)												
Arthropoda																	
Crustacea																	
Malacostraca																	
Amphipoda	Amphipods sp.	1.0 (.010)			0.33 (.0033)												

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	Density	3.0		1.0	1.32										1.0	1.0	0.67
	Biomass	.051		.008	.0197										.050	.028	.0260
Number of Species		3.0		1.0	1.33										1.0	1.0	0.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta	Unknown fragments						1.0 (.010)	1.0 (.003)	0.67 (.0043)			1.0 (.032)	0.33 (.0107)	1.0 (.122)	1.0 (.076)		0.67 (.0660)
Nemertea																	
Cerebratulus	Juvenile sp.											2.0 (.018)	0.67 (.0060)				
Arthropoda																	
Crustacea																	
Malacostraca																	
Amphipoda	Amphipods sp.	1.0 (.003)	1.0 (.002)		0.67 (.0017)			1.0 (.004)	0.33 (.0013)								
	*************																
	Density	1.0	1.0		0.67		1.0	1.0	0.33			3.0	1.0	1.0	1.0		0.67
	Biomass	.003	.002		.0017		.010	.007	.0057			.050	.0167	.122	.076		.0660
Number of Species		1.0	1.0		0.67		1.0	2.0	1.0			2.0	0.67	1.0	1.0		0.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 17,18 March 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida Polychaeta	Unknown fragments		1.0 (.082)	1.0 (.010)	0.67 (.0307)												
Sipuncula	Unknown sp.							1.0 (.020)	0.33 (.0067)								
Nemertea Cerebratula	Adult sp.											1.0 (1.225)	0.33 (.4083)			1.0 (.145)	0.33 (.0483)
	Juvenile						3.0 (.042)		1.0 (.0140)	1.0 (.002)			0.33 (.0007)				
Arthropoda Crustacea Malacostraca Decapoda	Pinnixia sp.			1.0 (.005)	0.33 (.0017)												
	Shrimp			1.0 (.062)	0.33 (.0207)					1.0 (.033)			0.33 (.0110)			1.0 (.030)	0.33 (.0100)
Amphipoda	Amphipods sp.			1.0 (.008)	0.33 (.0027)			4.0 (.019)	1.33 (.0063)			1.0 (.005)	0.33 (.0017)				
Tanadace	Tanadaceans sp.							1.0 (.001)	0.33 (.0003)								
Echinodermata	Brittle Star		1.0 (.002)		0.33 (.0007)												
								************									
	Density		1.0	4.0	1.67		3.0	6.0	3.0	2.0		2.0	1.33			2.0	0.67
	Biomass		.084	.085	.0565		.042	.040	.0273	.035		1.230	.4217			.175	.0583
	Number of Species		1.0	4.0	1.67		1.0	3.0	1.33	2.0		2.0	1.33			2.0	0.67
								************									
Cumulative	Density	9.0	10.0	8.0	8.98	4.0	8.0	8.0	6.33	6.0	1.0	6.0	4.33	2.0	3.0	4.0	2.33
Cumulative	Biomass	.074	.190	.273	.1793	.216	.278	.050	.1813	.300	.012	1.288	.5334	.135	.132	.205	.1573
Cumulative	Number of Species	6.0	6.0	8.0	6.67	2.0	5.0	6.0	4.33	5.0	1.0	3.0	3.0	2.0	3.0	4.0	3.01

Field and Laboratory Description of Sediment Grab Sample

Sampled 17,18 March 1976

	Station 1				Station 2				Station 3				Station 4			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
pth	200	200	200	200.00	198	196	198	197.33	212	198	205	205.00	216	216	216	216.00
mple Volume - Litres	16.0	15.0	16.0	15.67	15.0	10.0	10.0	11.67	16.0	11.0	16.0	14.33	16.0	16.0	16.0	16.00
mple Residue ml/l	37.5	173.3	40.6	83.80	131.7	50.0	15.0	65.56	168.7	95.5	85.9	116.70	54.7	68.7	37.5	53.63
rcent Rock	0	0	0	0	0	0	0	0	0	21.5	46.9	22.80	3.1	0	0	1.04
lume Rock ml/l	0	0	0	0	0	0	0	0	0	20.5	40.3	20.26	1.9	0	0	0.63
rcent Wood & Fibers	100.0	100.0	99.9	99.97	99.9	100.0	100.0	99.96	100.5	78.9	119.7	99.70	96.5	100.0	100.0	98.83
lume Wood & Fibers ml/l	37.5	173.3	40.6	83.80	131.6	50.0	15.0	65.53	168.8	75.0	45.7	96.50	52.8	68.7	37.5	53.00
rcent Wood	30.0	82.6	80.0	64.20	76.5	90.0	5.0	57.17	78.8	69.5	39.7	62.67	85.3	26.7	20.0	44.00
lume Wood ml/l	11.2	143.3	32.5	62.33	100.8	45.0	.7	48.83	132.2	66.4	34.1	77.56	46.7	18.4	7.5	24.20
rcent Fibers	70.0	17.3	19.9	35.73	23.3	10.0	95.0	42.77	21.6	9.0	13.5	14.70	11.1	73.1	80.0	54.73
lume Fibers ml/l	26.2	30.0	8.1	21.43	30.8	5.0	14.2	16.67	36.6	8.6	11.6	18.93	6.1	50.3	30.0	28.80
rficial Thickness Layer	1"	1"	.5"	.8"	0	0	0	0	0	2"	4"	3"	0	0	0	0
lor Sediment	B/b	B/b	b/B		b	b	b		B/b/B	b/B	b/B/g		b/g/B	b	b/B	
S Odor	YES	YES	NO		YES	NO	S		S	YES	NO		S	NO	S	
sociated Debris																
Oil	X	X	X		X				X	X	X			X		
Coal																
Seeds	X	X								X						
Metals																
Glass																
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 17,18 March 1976

	Station 5				Station 6				Station 7				Station 8			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
pth	190	194	192	192.00	196	194	192	194.00	198	198	199	198.33	212	210	210	210.67
mple Volume - Litres	10.0	9.0	8.0	9.0	12.0	10.0	7.0	9.67	6.0	6.0	6.0	16.0	16.0	16.0	16.0	16.0
mple Residue ml/l	135.0	55.6	187.5	126.03	214.6	211.0	85.7	170.43	291.7	154.2	158.3	201.40	159.4	167.2	87.5	138.03
rcent Rock	7.4	16.9	8.0	11.77	10.	5.6	15.0	10.23	.5	.8	4.9	2.07	1.7	3.8	1.4	2.30
lume Rock ml/l	10.0	9.4	.5	6.63	21.6	12.0	12.9	15.50	1.7	1.3	7.9	3.63	2.8	6.5	1.2	3.50
rcent Wood & Fibers	92.6	82.9	92.0	89.16	89.9	91.3	84.9	38.72	97.6	98.9	95.0	97.17	98.2	96.1	98.5	97.60
lume Wood & Fibers ml/l	125.0	46.1	172.5	114.53	193.0	54.5	72.8	106.77	290.0	152.6	150.3	197.63	28.2	160.7	86.2	91.70
rcent Wood	86.3	79.8	86.0	84.03	63.7	65.4	70.0	66.37	62.5	89.9	93.6	82.00	89.4	90.0	89.2	89.53
lume Wood ml/l	116.5	44.4	161.2	107.37	136.7	144.5	60.0	113.73	187.5	138.7	148.3	158.17	142.5	150.5	78.1	123.70
rcent Fibers	6.2	3.0	6.0	5.07	26.2	25.8	14.9	22.30	35.1	9.0	1.3	15.13	8.8	6.1	9.2	8.03
lume Fibers ml/l	8.5	1.7	11.2	7.13	56.3	54.5	12.8	41.20	102.5	13.9	2.1	39.50	14.1	10.2	8.1	10.80
rficial Thickness Layer	½"	½"	0		0	½"	0		¼"	¼"	0		0	¼"	1/16	
lor Sediment	B/b	B/b	b		b	B/b	b		B/b	B/b	B/b		b	B/b	B/b	
S Odor	NO	S	NO		NO	NO	NO		NO	S	NO		YES	YES	YES	
sociated Debris																
Oil	X	X	X			X			X	X			X	X	X	
Coal										X						
Seeds										X			X			
Metals																
Glass					X	X								X		
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Crab Sample

Sampled 17,18 March 1976

	Station 9				Station 10				Station 11				Station 12			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
.th	190	190	190	190.00	196	188	190	195.33	202	198	210	203.33	208	208	206	207.33
mple Volume - Litres	6.0	10.0	10.0	8.67	10.0	10.0	10.0	10.00	6.0	8.0	4.0	6.00	11.0	14.0	10.0	11.67
mple Residue ml/l	141.7	40.0	85.0	88.90	75.0	50.0	25.0	50.0	100.0	81.2	112.5	97.90	209.1	164.3	120.0	164.47
rcent Rock	5.0	3.0	6.4	4.80	0	60.0	10.0	23.33	10.0	49.9	50.0	36.66	0	0	3.8	1.26
lume Rock ml/l	7.1	12.0	5.5	8.20	0	30.0	2.5	10.83	10.0	40.6	56.2	35.60	0	0	4.5	1.50
rcent Wood & Fibers	94.9	70.0	93.5	86.13	100.0	40.0	90.0	76.67	90.0	49.9	58.8	66.23	99.9	99.9	96.2	98.67
lume Wood & Fibers ml/l	134.5	28.0	79.5	80.67	75.0	20.0	22.5	39.17	90.0	40.6	56.2	62.27	209.0	164.2	115.5	162.90
rcent Wood	79.9	60.0	67.0	68.97	90.0	25.0	90.0	68.33	90.0	40.0	48.9	59.63	94.9	65.1	58.7	72.90
lume Wood ml/l	113.3	24.0	57.0	64.77	67.5	12.5	22.5	34.17	90.0	32.5	55.1	59.20	198.6	107.1	70.5	125.40
rcent Fibers	14.9	10.0	26.4	17.10	10.0	15.0	0	8.33	0	9.9	9.9	6.60	4.9	34.7	37.5	25.70
lume Fibers ml/l	21.2	4.0	22.5	15.90	7.5	7.5	0	5.00	0	8.1	1.1	3.07	10.4	57.1	45.0	37.50
rficial Thickness Layer	1/16	¼	0		1/16	NR	0		0	NR	0		NR	NR	NR	
lor Sediment	B/b	B/b	B/b		B/b	B/b	b		b	B/b	b		B/b	B/b	B/b	
S Odor	YES	YES	S		S	YES	YES		S	YES	YES		NO	YES	NO	
sociated Debris:																
Oil	X	X			X	X	X			X			X		X	
Coal											X			X	X	X
Seeds																
Metals									X		X					
Glass																
Brick																
Blue Clay																

203

Field and Laboratory Description of Sediment Grab Sample

Sampled 17,18 March 1976

	Station 13				Station 14				Station 15				Station 16			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
pth	182	182	182	182.00	188	188	188	188.00	198	192	194	194.67	204	204	204	204.00
mple Volume - Litres	16.0	16.0	16.0	16.00	14.0	12.0	13.0	13.00	10.0	15.0	10.0	11.67	16.0	15.0	15.0	15.33
mple Residue ml/l	90.6	100.0	90.6	93.73	110.7	108.3	107.7	108.90	140.0	93.3	140.0	124.43	78.1	113.3	66.7	86.03
rcent Rock	4.9	5.0	24.0	11.30	5.0	15.4	5.0	8.47	7.1	5.0	.7	4.27	4.0	0	0	1.33
lume Rock ml/l	4.5	5.0	21.8	10.43	5.5	16.7	5.4	9.20	10.0	4.7	1.0	5.23	3.1	0	0	1.0
rcent Wood & Fibers	95.0	95.0	76.0	88.67	94.5	84.6	94.9	91.33	92.8	95.0	99.2	95.73	95.9	100.0	99.9	98.60
lume Wood & Fibers ml/l	86.1	95.0	68.9	83.33	105.1	91.6	101.6	99.43	130.0	88.7	139.0	119.23	74.9	113.4	66.7	85.00
rcent Wood	83.1	73.1	69.3	75.17	89.9	58.0	81.4	76.43	70.0	1.2	90.0	53.73	92.9	95.0	97.0	94.97
lume Wood ml/l	75.3	73.1	62.8	70.40	99.6	62.9	87.7	83.40	98.0	1.2	126.0	75.07	72.6	107.7	64.7	81.67
rcent Fibers	11.9	21.9	6.7	13.50	4.9	26.5	13.5	14.97	22.8	93.7	9.2	41.90	2.8	5.0	2.9	3.60
lume Fibers ml/l	10.8	21.9	6.1	12.93	5.5	28.7	14.6	16.27	32.0	87.5	13.0	44.17	2.3	5.7	2.0	3.33
rficial Thickness Layer	NR	½/½	0		½	NR	NR		NR	NR	NR		NR	NR	NR	
lor Sediment	S/b	S/b/S	S/b/S		G/b	B/b	B/b		B/b	B/b	B/b		B/b	B/b	B/b	
S Odor	S	NO	NO		YES	S	NO		S	NO	S		NO	YES	YES	
sociated Debris																
Oil	X		X		X	X	X			X	X			X	X	
Coal																
Seeds			X			X				X	X			X	X	
Metals										X						
Glass			X													
Brick																
Blue Clay																

Field and Laboratory Description of Sediment Grab Sample

Sampled 17,18 March 1976

	Station 17				Station 18				Station 19				Station 20			
	1	2	3	x	1	2	3	x	1	2	3	x	1	2	3	x
pth	184.0	188.0	190.0	187.33	186.0	190.0	190.0	188.67	170	170	168	169.33	190	192	178.0	186.67
mple Volume - Litres	3.7	12.0	11.0	8.90	7.0	10.0	8.5	8.50	14.0	16.0	12.0	14.00	8.0	9.0	11.0	9.33
mple Residue ml/1	162.2	54.2	40.9	85.77	107.1	40.0	53.5	63.53	50.0	37.5	74.2	53.90	125.0	72.2	88.6	95.27
rcent Rock	89.9	106.0	95.1	97.00	88.3	95.0	94.0	92.43	90.0	40.0	81.0	70.33	72.4	90.0	71.5	77.97
lume Rock ml/1	145.9	57.5	38.9	80.77	94.6	38.0	50.3	60.97	45.0	15.0	60.1	40.03	90.6	65.0	63.7	73.10
rcent Wood & Fibers	9.9	4.9	.6	5.13	11.6	5.0	4.8	7.13	10.0	59.9	18.9	29.63	27.4	9.9	19.3	18.87
lume Wood & Fibers ml/1	16.2	2.7	2.0	6.97	12.5	2.0	2.6	5.70	5.0	22.5	14.0	13.83	34.3	7.2	25.2	22.23
rcent Wood	9.9	4.9	0	4.93	5.0	0	0	1.67	5.0	54.9	0	19.97	23.0	4.9	9.1	12.33
lume Wood ml/1	16.2	2.7	0	6.30	5.4	0	0	1.80	2.5	20.6	0	7.70	28.7	3.6	8.1	13.47
rcent Fibers	0	0	.6	.20	6.6	5.0	4.8	5.47	5.0	5.0	18.9	9.63	4.4	4.9	19.3	9.53
lume Fibers ml/1	0	0	2.0	.67	7.1	2.0	2.6	3.90	2.5	1.9	14.0	6.13	5.6	3.6	17.1	8.77
rficial Thickness Layer	¼	0	0		0	0	0		0	0	0		0	0	0	
lor Sediment	B/g	B/g	Bb/g		B/g	B/G	B/g		B/g	B/g	GB/Gg		B/g	B/g	B/g	
S Odor	NO	NO	NO		S	S	NO		NO	NO	NO		NO	YES	NO	
sociated Debris																
Oil						X										
Coal														X		
Seeds																
Metals																
Glass			X													
Brick																
Blue Clay																

Density of Worm Tubes, Elliott Bay
March 17,18, 1976

		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MR3										3.0	1.0	1.67	1.0			0.33
	MR8															2.0	0.67
	MR13										1.0		0.33				
Sand Tubes	SR3										1.0		0.33				
	SR4			3.0	1.00						13.0		4.33	4.0	16.0	6.0	3.67
	SF9			1.0	0.33							2.0	0.67		1.0		0.67
	SR1	2.0		2.0	1.33						6.0	12.0	6.00				
	SR7	200.0	7.0	27.0	78.00					7.0	20.0	6.0	11.00		1.0	6.0	2.33
	SR10	2.0			0.67						1.0	2.0	1.00				
	SR18		4.0		1.33	1.0			0.33								
	S13											1.0	0.33				
	SC1	4.0			1.33		1.0		0.33	2.0	10.0	18.0	10.00			2.0	0.67
	SC2													5.0			1.67
	SC5									1.0			0.33	1.0			0.33
Mucous Membrane Tubes	MT3	2.0			0.67												
	PC1										1.0		0.33				

Density of Worm Tubes, Elliott Bay
17,18 March 1976

		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF5						1.0		0.33								
Sand Tubes	SR4	2.0		1.0	1.00									10.0	8.0	1.0	6.33
	SR7			8.0	2.67	14.0	10.0		8.00		1.0		0.33	6.0	7.0	10.0	7.67
	SR18					1.0	3.0		1.33						1.0		0.33
	SC1					3.0			1.00						2.0	1.0	1.00
	SC5						1.0		0.33		7.0		2.33				
Mucous Membrane Tubes	MM2														2.0		0.67
	MM4			2.0	0.67												

Density of Worm Tubes, Elliott Bay
March 17, 18, 1976

		Station 9				Station 10				Station 11				Station 12			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Sand Tubes	SR4						1.0		0.33							6.0	2.00
	SR7														6.0		2.00
	SR14										1.0		0.33				
	SR18	1.0	1.0		0.67		5.0		1.67		5.0	1.0	2.00				
	SC1	3.0			1.00		2.0		0.67						3.0	2.0	1.67
	SC2									1.0		1.0	0.67				
	SC5	1.0	1.0	6.0	2.67										2.0		0.67
Mucous Tubes	MM5														1.0		0.33

915

Density of Worm Tubes, Elliott Bay
March 17, 18, 1976

		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MR3	1.0			0.33	1.0			0.33								
Sand Tubes	SF5			2.0	0.57												
	SF9						1.0		0.33								
	SR3	4.0			1.33		1.0		0.33	1.0	3.0	1.0	1.67				
	SR4	2.0			0.67	3.0	7.0	10.0	6.67			2.0	0.67				
	SR7													2.0	4.0		2.00
	SR10			2.0	0.67												
	SR14			14.0	4.67												
	SR18	1.0		1.0	0.67			1.0	0.33			1.0	0.33				
	SC1	12.0	5.0	19.0	12.00		5.0		1.67		1.0		0.33	1.0			0.33
	SC2			3.0	1.00												
	SC5						1.0		0.33			4.0	1.33				

Density of Worm Tubes, Elliott Bay
March 17, 18, 1976

		Station 17				Station 18				Station 19				Station 20			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mud Tubes	MF1											2.0	0.67			1.0	0.33
	MF3													1.0			0.33
	MF6			3.0	1.00												
	MR3	3.0			1.00												
	MR7						5.0		1.67	6.0		7.0	4.33	8.0		2.0	3.33
	MR9											2.0	0.67				
Sand Tubes	SF9	1.0	2.0		1.00	1.0			0.33								
	SR1	70.0		100.0	56.67	25.0	10.0	30.0	21.67						1.0		0.33
	SR3			1.0	0.33	2.0	1.0		1.00								
	SR4			9.0	3.00	15.0	1.0	1.0	5.67	3.0		8.0	3.67	3.0		1.0	1.33
	SR5	3.0	1.0		1.33												
	SR7	20.0	3.0	50.0	24.33	2.0	50.0	9.0	20.33	5.0	30.0	28.0	21.00	15.0	6.0	28.0	16.33
	SR10	17.0		22.0	13.00	1.0		3.0	1.33								
	SR14	2.0			0.67												
	SR16		2.0		0.67			7.0	2.33								
	SI3		4.0		1.33												
	SC1	5.0	10.0	7.0	7.33	11.0	22.0	14.0	15.67	22.0	28.0	18.0	22.67	35.0	25.0	38.0	32.67
	SC2	7.0	1.0		2.67		1.0		0.33	4.0		4.0	2.67	2.0		2.0	1.33
Mucous Membrane Tubes	MM3					3.0			1.0								
	PC2						2.0		0.67								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: x̄	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: x̄	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: x̄	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: x̄
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	4.0 (.039)	2.0 (.014)	5.0 (.212)	3.67 (.0883)	2.0 (.093)	4.0 (.128)	3.0 (.134)	3.00 (.1183)	3.0 (.054)	3.0 (.157)	3.0 (.064)	3.00 (.0917)	2.0 (.025)	3.0 (.247)	4.0 (.106)	3.00 (.1260)
Goniadidae	Glycinde picta	2.0 (.057)		1.0 (.161)	1.00 (.0727)	1.0 (.087)	1.0 (.030)		0.67 (.0390)	1.0 (.035)		2.0 (.476)	1.00 (.1703)		1.0 (.025)	1.0 (.002)	0.67 (.0030)
Lumbrineridae	Lumbrineris luti	3.0 (.010)	2.0 (.017)		1.67 (.0090)	2.0 (.017)			0.67 (.0057)		3.0 (.020)	4.0 (.034)	2.33 (.0180)				
Nephtyidae	Nephtys ferruginea	3.0 (.001)	2.0 (.022)	5.0 (.034)	3.33 (.0190)	1.0 (.004)	1.0 (.003)		0.67 (.0023)	2.0 (.009)			0.67 (.0030)		1.0 (.010)	3.0 (.012)	1.33 (.0073)
Onuphidae	Onuphis iridescens	2.0 (.068)		2.0 (.023)	1.33 (.0303)			2.0 (.003)	0.67 (.0010)	3.0 (.409)	1.0 (.002)	6.0 (.410)	3.33 (.2737)	1.0 (.047)	2.0 (.227)	1.0 (.002)	1.33 (.0920)
Phyllodocidae	Phyllodoce groenlandica			1.0 (.140)	0.33 (.0467)												
	Phyllodoce williamsi		2.0 (.057)	1.0 (.044)	1.00 (.0337)	4.0 (.033)			1.33 (.0110)		1.0 (.060)		0.33 (.0200)				
Polynoidae	Polynoid sp.					1.0 (.004)	2.0 (.032)		1.0 (.0120)		1.0 (.012)	1.0 (.031)	0.67 (.0143)		1.0 (.005)	2.0 (.056)	1.00 (.0203)
Syllidae	Syllis sp.	1.0 (.001)			0.33 (.0003)			1.0 (.010)	0.33 (.0033)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: x̄	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: x̄	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: x̄	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: x̄
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Melinna cristata					2.0 (.029)			0.67 (.0097)								
Capitellidae	Heteromastus cf. filobranchus	2.0 (.023)		9.0 (.060)	3.67 (.0277)	11.0 (.271)	7.0 (.117)	6.0 (.105)	8.00 (.1643)	6.0 (.081)	3.0 (.033)	6.0 (.054)	5.00 (.0560)			3.0 (.021)	1.00 (.0070)
Cirratulidae	Chaetozone setosa	1.0 (.005)			0.33 (.0017)							1.0 (.001)	0.33 (.0003)				
Disomidae	Unknown sp.		1.0 (.001)		0.33 (.0003)												
Flabelligeridae	Unknown sp.														1.0 (.052)		0.33 (.0173)
Maldanidae	Asychis similis							1.0 (.535)	0.33 (.1783)	1.0 (.194)	1.0 (.710)		0.67 (.3013)				
	Euclymene zonalis		7.0 (.070)	8.0 (.088)	5.00 (.0527)	2.0 (.006)		7.0 (.078)	2.67 (.0280)	2.0 (.018)	1.0 (.009)	3.0 (.023)	2.00 (.0167)		5.0 (.187)	3.0 (.013)	2.67 (.0667)
	Maldane glebifex	12.0 (.027)		1.0 (.002)	4.33 (.0097)												
	Praxilella affinis	1.0 (.060)			0.33 (.0200)												
	Praxilella gracilis		1.0 (.032)	2.0 (.233)	1.00 (.0883)		1.0 (.448)	1.0 (.011)	0.67 (.1530)	2.0 (.314)	1.0 (.175)		1.00 (.1630)	4.0 (.328)	4.0 (1.346)		2.67 (.5580)
Opheliidae	Ammotrypane aulogaster		1.0 (.032)		0.33 (.0107)	1.0 (.027)			0.33 (.0090)							1.0 (.020)	0.33 (.0067)
Oweniidae	Myriochele heeri														1.0 (.010)	1.0 (.002)	0.67 (.0040)
Pectinariidae	Pectinaria californiensis					1.0 (.048)	1.0 (.054)		0.67 (.0340)		1.0 (.163)	1.0 (.068)	0.67 (.0770)				

312

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Sedentaria																	
Spionidae	Polydora caraalia	1.0 (.005)			0.33 (.0017)												
	Laonice cirrata	3.0 (.381)	2.0 (.449)		1.67 (.2767)	3.0 (1.412)	2.0 (.245)	1.0 (.092)	2.00 (.5830)	1.0 (.129)	2.0 (.480)	1.0 (.268)	1.33 (.2923)	2.0 (1.205)	3.0 (1.402)	2.0 (.485)	2.33 (1.0307)
	Prionospio malmgreni			1.0 (.002)	0.33 (.0007)					3.0 (.032)		1.0 (.003)	1.33 (.0117)			1.0 (.012)	0.33 (.0040)
Terebellidae	Artacama conifera		1.0 (.015)	1.0 (.045)	0.67 (.0200)							1.0 (.112)	0.33 (.0373)				
Trichobranchidae																	
	Trichobranchus glacialis		1.0 (.038)		0.33 (.0127)	1.0 (.020)			0.33 (.0067)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 1: 1	Station 1: 2	Station 1: 3	Station 1: $\bar{x}$	Station 2: 1	Station 2: 2	Station 2: 3	Station 2: $\bar{x}$	Station 3: 1	Station 3: 2	Station 3: 3	Station 3: $\bar{x}$	Station 4: 1	Station 4: 2	Station 4: 3	Station 4: $\bar{x}$
		Replicate and Mean Density and Biomass*															
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.	3.0 (.008)			1.00 (.0027)			2.0 (.065)	0.67 (.0217)		3.0 (.004)	9.0 (.014)	4.00 (.0060)	1.0 (.003)	1.0 (.001)	2.0 (.017)	1.33 (.0070)
	Littorina sp.										1.0 (.002)		0.33 (.0007)				
	Mitrella gouldi	4.0 (.208)			1.33 (.0693)		2.0 (.156)	4.0 (.170)	2.00 (.1087)		3.0 (.167)		1.00 (.0557)	3.0 (.102)		2.0 (.020)	1.67 (.0407)
	Oenopota sp.	1.0 (.010)			0.33 (.0033)		1.0 (.066)		0.33 (.0220)			1.0 (.014)	0.33 (.0047)				
	Polinices sp.							1.0 (.078)	0.33 (.0260)								
Opisthobranchia	Odostomia sp.	1.0 (.017)			0.33 (.0057)		2.0 (.080)		0.67 (.0267)								
	Turbonilla sp.															1.0 (.001)	0.33 (.0003)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Ascila castrensis										1.0 (.397)		0.33 (.1323)				
	Axinopsida serricata	165.0 (.616)	121.0 (.335)	176.0 (.586)	154.00 (.5123)	214.0 (.824)	93.0 (.378)	216.0 (.747)	174.33 (.6497)	217.0 (1.055)	72.0 (.834)	188.0 (.690)	159.00 (.8597)	73.0 (.467)	81.0 (.405)	266.0 (.769)	140.00 (.5470)
	Cardiomya oldroydi	1.0 (.004)	1.0 (.021)	2.0 (.015)	1.33 (.0133)			1.0 (.027)	0.33 (.0090)		2.0 (.015)		0.67 (.0050)				
	Compsomyax subdiaphana						1.0 (.613)		0.33 (.2043)	1.0 (.087)		2.0 (2.057)	1.00 (.7147)				
	Cardita ventricosa	1.0 (.092)			0.33 (.0307)												
	Macoma alaskansis	1.0 (.419)			0.33 (.1397)	1.0 (.350)		1.0 (.526)	0.67 (.2920)	2.0 (.277)	1.0 (.221)		1.00 (.1660)				
	Macoma carlottensis	13.0 (.292)	30.0 (.451)	17.0 (.331)	20.0 (.3580)	58.0 (.688)	29.0 (.693)	28.0 (.262)	38.33 (.5477)	27.0 (.620)	17.0 (.331)	11.0 (.119)	18.33 (.3567)	6.0 (.147)	7.0 (.104)	62.0 (.926)	25.00 (.3923)
	Macoma secta		2.0 (.015)		0.67 (.0050)			2.0 (.253)	0.67 (.0843)								
	Megacrenella columbiana											1.0 (.133)	0.33 (.0443)				
	Nemocardium centifilosum					1.0 (.030)	1.0 (.817)		0.67 (.2823)					1.0 (.083)			0.33 (.0277)
	Nucula tenuis	1.0 (.044)			0.33 (.0147)	6.0 (.213)	2.0 (.087)	4.0 (.151)	4.00 (.1503)	7.0 (.284)	2.0 (.064)	5.0 (.185)	4.67 (.1777)	4.0 (.140)	2.0 (.015)	5.0 (.154)	3.67 (.1030)
	Nuculana minuta	6.0 (.295)	2.0 (.034)	1.0 (.124)	3.00 (.1510)	6.0 (.383)	1.0 (.040)	2.0 (.033)	3.00 (.1520)		7.0 (.258)	3.0 (.082)	3.33 (.1133)	1.0 (.025)			0.33 (.0083)
	Pandora filosa											4.0 (.119)	1.33 (.0397)				
	Paravalucina tenuisculptis		1.0 (.063)		0.33 (.0210)	1.0 (.040)			0.33 (.0133)						2.0 (.161)		0.67 (.0537)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Pelecypoda	Spisula falcata	1.0 (.041)			0.33 (.0137)												

216

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5, February 1976

		Replicate and Mean Density and Biomass*															
		Station 1				Station 2				Station 3				Station 4			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	15.0	8.0	15.0	12.66	11.0	8.0	6.0	8.33	9.0	9.0	16.0	11.33	3.0	8.0	11.0	7.33
	Biomass	.176	.110	.614	.3000	.238	.193	.147	.1927	.507	.251	1.015	.5910	.072	.514	.178	.2546
	Number of species	6.0	4.0	6.0	5.33	6.0	4.0	3.0	4.33	4.0	5.0	5.0	4.67	2.0	5.0	5.0	4.00
SEDENTARIA	Density	20.0	14.0	22.0	18.67	21.0	11.0	15.0	15.67	15.0	9.0	14.0	12.67	6.0	14.0	11.0	10.33
	Biomass	.501	.637	.430	.5229	1.813	.864	.821	1.1660	.768	1.570	.529	.9556	1.533	2.997	.553	1.6944
	Number of species	6.0	7.0	6.0	6.33	7.0	4.0	5.0	5.33	6.0	6.0	7.0	6.33	2.0	5.0	6.0	4.33
GASTROPODA	Density	9.0			2.99		5.0	7.0	4.00		7.0	10.0	5.66	4.0	1.0	5.0	3.33
	Biomass	.243			.0810		.302	.313	.2050		.173	.028	.0671	.105	.001	.038	.0480
	Number of species	4.0			1.33		3.0	3.0	2.00		3.0	2.0	1.67	2.0	1.0	3.0	2.00
PELECYPODA	Density	189.0	157.0	196.0	180.67	287.0	127.0	254.0	222.67	254.0	102.0	214.0	189.99	85.0	92.0	333.0	170.00
	Biomass	1.803	.919	1.056	1.2594	2.528	2.628	1.999	2.3849	2.323	2.120	3.385	2.6094	.862	.685	1.849	1.1320
	Number of species	8.0	6.0	4.0	6.00	7.0	6.0	7.0	6.67	5.0	7.0	7.0	6.33	5.0	4.0	3.0	4.00
TOTAL	Density	233.0	179.0	233.0	214.99	319.0	151.0	282.0	250.67	278.0	127.0	254.0	219.65	98.0	115.0	360.0	190.99
	Biomass	2.723	1.666	2.100	2.1633	4.579	3.987	3.280	3.9486	3.598	4.114	4.957	4.2231	2.572	4.197	2.618	3.1290
	Number of species	24.0	17.0	16.0	18.99	20.0	17.0	18.0	18.33	15.0	21.0	21.0	19.00	11.0	15.0	17.0	14.33

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	Glycera capitata	6.0 (.411)	3.0 (.067)	1.0 (.005)	3.33 (.1610)	1.0 (.117)		3.0 (.093)	1.33 (.0700)	4.0 (.064)	3.0 (.075)	1.0 (.056)	2.67 (.0650)		4.0 (.051)	3.0 (.050)	2.33 (.0337)
Goniadidae	Goniada brunnea									2.0 (.020)			0.67 (.0067)				
	Glycinde picta		1.0 (.061)		0.33 (.0203)			1.0 (.002)	0.33 (.0007)	1.0 (.237)			0.33 (.0790)	3.0 (.041)	1.0 (.285)	2.0 (.025)	2.00 (.1170)
Lumbrineridae	Lumbrineris zonata									1.0 (.003)			0.33 (.0010)				
	Lumbrineris luti			2.0 (.013)	0.67 (.0043)		1.0 (.006)	5.0 (.023)	2.00 (.0097)	1.0 (.004)		2.0 (.007)	1.00 (.0037)	1.0 (.006)			0.33 (.0020)
Nephtyidae	Nephtys ferruginea	1.0 (.009)	2.0 (.037)	2.0 (.007)	1.67 (.0177)		2.0 (.014)	3.0 (.022)	1.67 (.0120)			2.0 (.031)	0.67 (.0103)				
Onuphidae	Onuphis iridescens	3.0 (.090)	2.0 (.075)	1.0 (.011)	2.00 (.0587)	3.0 (.106)	2.0 (.139)	3.0 (.285)	2.67 (.1767)	3.0 (.115)		3.0 (.060)	2.00 (.0583)	3.0 (.023)	1.0 (.041)	5.0 (.343)	3.00 (.1357)
Phyllodocidae	Eteone sp.		1.0 (.008)		0.33 (.0027)												
	Phyllodoce multisetosa					1.0 (.009)			0.33 (.0030)								
	Phyllodoce williamsi		1.0 (.004)	1.0 (.013)	0.67 (.0057)	1.0 (.049)			0.33 (.0163)					1.0 (.010)		1.0 (.025)	0.67 (.0117)
	Planktonic phyllodocidae							2.0 (.009)	0.67 (.0030)								
	Phyllodoce sp.							1.0 (.016)	0.33 (.0053)								
Polynoidae	Polynoid sp.	1.0 (.013)		1.0 (.014)	0.67 (.0090)			1.0 (.007)	0.33 (.0023)							2.0 (.040)	0.67 (.0133)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5: 1	Station 5: 2	Station 5: 3	Station 5: $\bar{x}$	Station 6: 1	Station 6: 2	Station 6: 3	Station 6: $\bar{x}$	Station 7: 1	Station 7: 2	Station 7: 3	Station 7: $\bar{x}$	Station 8: 1	Station 8: 2	Station 8: 3	Station 8: $\bar{x}$
Errantia																	
Syllidae	Syllis sp.													1.0 (.003)		1.0 (.003)	0.67 (.0020)

Replicate and Mean Density and Biomass*

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5: 1	2	3	x̄	Station 6: 1	2	3	x̄	Station 7: 1	2	3	x̄	Station 8: 1	2	3	x̄
		Replicate and Mean Density and Biomass*															
Annelida																	
Polychaeta																	
Sedentaria																	
* Capitellidae	Heteromastus cf. filobranchus	1.0 (.055)	3.0 (.034)	3.0 (.081)	2.33 (.0567)	3.0 (.039)	6.0 (.111)	8.0 (.356)	5.67 (.1687)	7.0 (.104)	3.0 (.038)	4.0 (.151)	4.67 (.0977)		4.0 (.063)		1.33 (.0210)
	Mediomastus californiensis															1.0 (.020)	0.33 (.0067)
Disomidae	unknown sp.		1.0 (.006)		0.33 (.0020)												
Maldanidae	Euclymene zonalis	3.0 (.039)	3.0 (.030)	4.0 (.043)	3.33 (.0373)	1.0 (.493)		3.0 (.027)	1.33 (.1733)			3.0 (.021)	1.00 (.0070)	2.0 (.020)		6.0 (.025)	2.67 (.0150)
	Maldane glebifex			3.0 (.020)	1.00 (.0067)									1.0 (.005)			0.33 (.0017)
	Praxillella gracilis			3.0 (.023)	1.00 (.0077)	1.0 (.920)		1.0 (.060)	0.67 (.3267)			3.0 (.521)	1.00 (.1737)		1.0 (.111)	3.0 (.275)	1.33 (.1287)
Opheliidae	Ammotrypane aulogaster														1.0 (.018)		0.33 (.0060)
Pectinariidae	Pectinaria californiensis									6.0 (.095)			2.00 (.0317)				
Sabellidae	Megalomma splendida									1.0 (.162)		1.0 (.180)	0.67 (.1140)				
Spionidae	Laonice cirrata		3.0 (.390)	3.0 (.134)	2.00 (.1747)	1.0 (.075)			0.33 (.0250)	2.0 (.223)		4.0 (.762)	2.00 (.3283)	1.0 (.080)	2.0 (.092)		1.00 (.0573)
	Prionospio malgreni							1.0 (.018)	0.33 (.0060)								
Sternaspidae	Sternaspis fossor									1.0 (.071)			0.33 (.0237)				
Terebellidae	Artacama conifera	1.0 (.050)	1.0 (.060)		0.67 (.0367)		1.0 (.031)	1.0 (.090)	0.67 (.0403)								
*Capitellidae	Unknown sp.															1.0 (.015)	0.33 (.005)

220

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 5				Station 6				Station 7				Station 8			
		Replicate and Mean Density and Biomass*															
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.		2.0 (.002)		0.67 (.0007)					1.0 (.001)	1.0 (.001)	2.0 (.002)	1.33 (.0013)	1.0 (.001)		4.0 (.007)	1.67 (.0027)
	Mitrella gouldi		2.0 (.162)		0.67 (.0540)						1.0 (.050)	2.0 (.050)	1.00 (.0333)		7.0 (.352)	3.0 (.159)	3.33 (.1703)
	Oenopota sp.									1.0 (.060)	1.0 (.037)		0.67 (.0323)	1.0 (.001)			0.33 (.0003)
	Polinices sp.														1.0 (.364)		0.33 (.1213)
Opisthobranchia	Turbonilla sp.															1.0 (.004)	0.33 (.0013)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Axinopsida serricata	81.0 (.384)	276.0 (1.749)	130.0 (.563)	162.33 (.8987)	104.0 (.474)	109.0 (.509)	204.0 (.520)	139.00 (.5010)	194.0 (.853)	133.0 (.570)	122.0 (.523)	149.67 (.6487)	146.0 (.502)	109.0 (.791)	314.0 (1.123)	189.67 (.8053)
	Cardiomya oldroydi		3.0 (.016)		1.00 (.0053)	2.0 (.017)		1.00 (.001)	1.00 (.0060)	1.0 (.002)		1.0 (.001)	0.67 (.0010)	2.0 (.048)		2.0 (.005)	1.33 (.0177)
	Compsomyax subdiaphana		3.0 (10.60)		1.0 (3.5333)			6.0 (1.909)	2.00 (.6363)		2.0 (3.188)	1.0 (.040)	1.00 (1.0760)				
	Lucinoma annulata						1.0 (1.035)		0.33 (.3450)								
	Macoma alaskansis							1.0 (.150)	0.33 (.0500)		2.0 (1.034)	2.0 (.030)	1.33 (.3547)				
	Macoma carlottensis	15.0 (.281)	21.0 (.430)	15.0 (.555)	17.00 (.4220)	7.0 (.169)	10.0 (.134)	27.0 (.551)	14.67 (.2847)	17.0 (.547)	6.0 (.086)	22.0 (.489)	15.00 (.3740)	40.0 (.484)	12.0 (.108)	29.0 (.211)	27.00 (.2677)
	Megacrenella columbiana					1.0 (.293)		1.0 (.264)	0.67 (.1857)							1.0 (1.046)	0.33 (.3487)
	Nemocardium sp.	2.0 (.276)		1.0 (.560)	1.00 (.2787)						1.0 (.052)		0.33 (.0173)				
	Nucula tenuis	1.0 (.010)	3.0 (.255)	2.0 (.015)	2.00 (.0933)	2.0 (.153)	1.0 (.001)	1.0 (.022)	1.33 (.0587)		1.0 (.008)	3.0 (.126)	1.33 (.0447)	3.0 (.062)	4.0 (.129)	4.0 (.107)	3.67 (.0993)
	Nuculana minuta	2.0 (.063)	4.0 (.188)	1.0 (.037)	2.33 (.0960)	1.0 (.012)	2.0 (.040)	2.0 (.062)	1.67 (.0380)	8.0 (.193)	3.0 (.116)	8.0 (.202)	6.33 (.1703)	1.0 (.006)	1.0 (.190)	1.0 (.008)	1.0 (.0680)
	Paravalucina tenuisculptis															2.0 (.392)	0.67 (.1307)
	Yoldia sp.							1.0 (.178)	0.33 (.0593)								

222

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

		Replicate and Mean Density and Biomass*															
		Station 5				Station 6				Station 7				Station 8			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
ERRANTIA	Density	11.0	10.0	8.0	9.67	6.0	5.0	19.0	9.99	12.0	3.0	8.0	7.67	9.0	6.0	14.0	9.67
	Biomass	.523	.252	.063	.2794	.281	.159	.457	.2990	.443	.075	.154	.2240	.083	.377	.486	.3154
	Number of species	4.0	6.0	6.0	5.33	4.0	3.0	8.0	5.00	6.0	1.0	4.0	3.67	5.0	3.0	6.0	4.67
SEDENTARIA	Density	5.0	11.0	16.0	10.66	6.0	7.0	14.0	9.0	17.0	3.0	15.0	11.67	4.0	8.0	11.0	7.65
	Biomass	.144	.520	.301	.3218	1.527	.142	.551	.7400	.655	.038	1.635	.7761	.105	.284	.335	.2414
	Number of species	3.0	5.0	5.0	4.33	4.0	2.0	5.0	3.67	5.0	1.0	5.0	3.67	3.0	4.0	4.0	3.67
GASTROPODA	Density		4.0		1.33					2.0	3.0	4.0	3.00	2.0	8.0	8.0	5.99
	Biomass		.164		.0547					.061	.088	.052	.0669	.002	.716	.170	.2959
	Number of species		2.0		0.67					2.0	3.0	2.0	2.33	2.0	2.0	3.0	2.33
PELECYPODA	Density	101.0	310.0	149.0	186.66	117.0	123.0	244.0	161.33	220.0	143.0	159.0	175.66	192.0	126.0	353.0	223.67
	Biomass	1.014	13.238	1.730	5.3273	1.118	1.719	3.657	2.1647	1.590	5.0540	1.411	2.6867	1.1020	1.218	2.892	1.7374
	Number of species	5.0	6.0	5.0	3.67	6.0	5.0	9.0	6.67	4.0	7.0	7.0	6.00	5.0	4.0	7.0	5.33
TOTAL	Density	117.0	335.0	173.0	208.32	129.0	135.0	277.0	180.32	251.0	157.0	186.0	198.00	207.0	148.0	386.0	246.98
	Biomass	1.681	14.174	2.094	5.9830	2.926	2.020	4.665	3.2037	2.754	5.255	3.252	3.7537	1.292	2.595	3.883	2.5901
	Number of species	12.0	19.0	16.0	15.67	14.0	10.0	22.0	15.33	17.0	12.0	18.0	15.67	15.0	13.0	20.0	16.0

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*	1.0 (.002)	5.0 (.186)	4.0 (.121)	3.33 (.1030)	7.0 (.234)	3.0 (.099)	3.0 (.099)	4.33 (.1440)		7.0 (.463)	2.0 (.023)	4.50 (.2430)	1.0 (.021)	2.0 (.033)	4.0 (.042)	2.33 (.0320)
Goniadidae	*Glycinde picta*	1.0 (.045)	1.0 (.006)		0.67 (.0170)		1.0 (.008)	1.0 (.008)	0.67 (.0057)					1.0 (.003)			0.33 (.0010)
Lumbrineridae	*Lumbrineris zonata*															1.0 (.012)	0.33 (.0040)
	Lumbrineris luti		1.0 (.001)	2.0 (.015)	1.00 (.0053)	4.0 (.018)	2.0 (.007)	2.0 (.007)	2.67 (.0100)			2.0 (.004)	1.0 (.002)		2.0 (.003)	2.0 (.005)	1.33 (.0027)
	Ninoe gemmea			1.0 (.025)	0.33 (.0083)									1.0 (.005)		1.0 (.170)	0.67 (.0583)
Nephtyidae	*Nephtys ferruginea*		1.0 (.001)	1.0 (.008)	0.67 (.0030)	2.0 (2.018)	3.0 (.039)	3.0 (.039)	2.67 (.6980)			1.0 (.002)	.50 (.0010)			3.0 (.011)	1.0 (.0037)
Neridae	*Nereis procera*					1.0 (.017)			0.33 (.0057)								
Onuphidae	*Onuphis iridescens*	1.0 (.001)	1.0 (.056)	3.0 (.205)	1.67 (.0873)	1.0 (.029)	1.0 (.035)	1.0 (.035)	1.0 (.0330)		2.0 (.040)	2.0 (.037)	2.00 (.0385)	3.0 (.079)	4.0 (.020)		2.33 (.0330)
Phyllodocidae	*Eteone sp.*										1.0 (.004)		.50 (.0020)			1.0 (.006)	0.33 (.0020)
	Phyllodoce williamsi											1.0 (.013)	.50 (.0065)				
Polynoidae	*Polynoid sp.*					4.0 (.093)			1.33 (.0310)		1.0 (.010)		.50 (.0050)				
Syllidae	*Syllis sp.*					2.0 (.008)			0.67 (.0027)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 9: 1	Station 9: 2	Station 9: 3	Station 9: $\bar{x}$	Station 10: 1	Station 10: 2	Station 10: 3	Station 10: $\bar{x}$	Station 11: 1	Station 11: 2	Station 11: 3	Station 11: $\bar{x}$	Station 12: 1	Station 12: 2	Station 12: 3	Station 12: $\bar{x}$
Annelida																	
Polycnaeta																	
Sedentaria																	
Ampharetidae	Unknown sp.										1.0 (.018)		0.50 (.009)				
	Ampharete goesi										3.0 (.020)		1.50 (.010)				
Capitellidae cf.	Heteromastus filobranchus		2.0 (.050)	2.0 (.026)	1.33 (.0253)		5.0 (.925)	5.0 (.925)	3.33 (.6167)		9.0 (.230)		4.50 (.115	4.0 (.030)	9.0 (.104)	7.0 (.124)	6.67 (.0860)
Disomidae	Unknown sp.										1.0 (.005)		0.50 (.0025)				
Maldanidae	Euclymene zonalis					3.0 (.021)	1.0 (.007)	1.0 (.007)	1.67 (.0117)			2.0 (.024)	1.0 (.012)	1.0 (.002)	2.0 (.004)	4.0 (.072)	2.33 (.0260)
	Praxilella gracilis	1.0 (.079)			0.33 (.0263)	2.0 (1.307)	1.0 (.214)	1.0 (.214)	1.33 (.5783)					1.0 (.448)			0.33 (.1493)
Opheliidae	Ammotrypane aulogaster															1.0 (.032)	0.33 (.0107)
Pectinariidae	Pectinaria californiensis	1.0 (.079)	6.0 (.146)		2.33 (.0750)									1.0 (.012)			0.33 (.0040)
Spionidae	Laonice cirrata	1.0 (.002)	4.0 (.464)		1.67 (.1553)	3.0 (.263)	2.0 (.390)	2.0 (.390)	2.33 (.3477)		3.0 (.572)	1.0 (.045)	2.0 (.3085)	1.0 (.808)	1.0 (.128)	2.0 (.441)	1.33 (.4590)
Terebellidae	Terebellides stroemi	1.0 (.027)			0.33 (.0090)											1.0 (.011)	0.33 (.0037)
	Trichobranchus glacialis	2.0 (.020)			0.67 (.0067)	1.0 (.029)			0.33 (.0097)								

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.		3.0 (.011)		1.00 (.0037)	2.0 (.002)	13.0 (.007)	1.0 (.001)	5.33 (.0033)						1.0 (.001)	1.0 (.006)	0.67 (.0023)
	Littorina sp.													1.0 (.022)			0.33 (.0073)
	Mitrella gouldi							1.0 (.018)	0.33 (.0060)		1.0 (.102)		0.33 (.0340)	1.0 (.059)	1.0 (.084)	2.0 (.025)	1.33 (.0560)
	Oenopota sp.		1.0 (.004)		0.33 (.0013)						1.0 (.046)		0.33 (.0153)	1.0 (.012)		1.0 (.002)	0.67 (.0047)
Opisthobranchia	Turbonilla sp.					1.0 (.011)			0.33 (.0037)						1.0 (.024)		0.33 (.0080)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Mollusca Pelecypoda (Bivalvia)	Acetocemia exima														1.0 (.055)		0.33 (.0183)
	Axinopsida serricata	96.0 (.345)	60.0 (.408)	190.0 (.845)	115.33 (.5327)	233.0 (.990)	380.0 (1.669)	241.0 (1.025)	284.67 (1.2880)		162.0 (.810)	169.0 (.610)	165.50 (.7100)	222.0 (.979)	123.0 (.720)	299.0 (1.426)	214.67 (1.0417)
	Cardiomya oldroydi		2.0 (.017)	1.0 (.089)	1.00 (.0353)			2.0 (.022)	0.67 (.0073)		1.0 (.015)	2.0 (.008)	1.50 (.0115)		1.0 (.005)		0.33 (.0017)
	Compsomyax subdiaphana	1.0 (.017)			0.33 (.0057)	1.0 (.027)			0.33 (.0090)					1.0 (.126)		1.0 (.306)	0.67 (.1440)
	Lucinoma annulata	1.0 (.008)		1.0 (.192)	0.67 (.0667)									1.0 (.072)	3.0 (.465)		1.33 (.1790)
	Macoma alaskensis						1.0 (.854)	2.0 (.123)	1.0 (.3257)		1.0 (1.950)		0.50 (.9750)	1.0 (.366)			0.33 (.1220)
	Macoma carliottensis	8.0 (.180)	16.0 (.455)	12.0 (.358)	12.00 (.3310)	27.0 (.262)	25.0 (.233)	31.0 (.429)	27.67 (.3080)		53.0 (.595)	29.0 (.241)	41.0 (.4180)	10.0 (.248)	12.0 (.116)	44.0 (.288)	22.00 (.2177)
	Macoma secta						1.0 (.026)		0.33 (.0087)						1.0 (.076)		0.33 (.0253)
	Nemocardium sp.			1.0 (.001)	0.33 (.0003)			2.0 (.126)	0.67 (.0420)		1.0 (.255)		0.50 (.1275)		2.0 (1.027)	2.0 (1.459)	1.33 (.8287)
	Nuculana minuta	3.0 (.070)		2.0 (.038)	1.67 (.0360)	7.0 (.105)		4.0 (.099)	3.67 (.0680)		9.0 (.239)	5.0 (.055)	7.0 (.1470)	7.0 (.159)	2.0 (.005)	3.0 (.100)	4.00 (.0880)
	Nucula tenuis			4.0 (.224)	1.33 (.0747)		6.0 (.147)	1.0 (.041)	2.33 (.0627)		1.0 (.051)	3.0 (.071)	2.0 (.0610)	4.0 (.198)	7.0 (.146)	5.0 (.239)	5.33 (.1943)

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

		Replicate and Mean Density and Biomass*															
		Station 9				Station 10				Station 11				Station 12			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
ERRANTIA	Density	3.0	9.0	11.0	7.67	21.0	10.0	10.0	13.67		11.0	8.0	9.50	7.0	8.0	12.0	9.00
	Biomass	.048	.250	.374	.2240	2.417	.188	.188	.9310		.517	.079	.2980	.222	.056	.246	.1747
	Number of species	3.0	5.0	5.0	4.33	7.0	5.0	5.0	5.67		4.0	5.0	4.50	4.0	3.0	6.0	4.33
SEDENTARIA	Density	6.0	12.0	2.0	6.67	9.0	9.0	9.0	8.99		17.0	3.0	10.0	8.0	12.0	15.0	11.67
	Biomass	.2070	.660	.026	.2976	1.620	1.536	1.536	1.5640		.845	.069	.4570	1.300	.236	.680	.7387
	Number of species	5.0	3.0	1.0	3.0	4.0	4.0	4.0	4.00		5.0	2.0	3.50	5.0	3.0	5.0	4.33
GASTROPODA	Density		4.0		1.33	3.0	13.0	2.0	5.99		2.0		1.0	3.0	3.0	4.0	3.33
	Biomass		.015		.0050	.013	.007	.019	.0130		.148		.0740	.0930	.1090	.033	.0783
	Number of species		2.0		0.67	2.0	1.0	2.0	1.67		2.0		0.67	3.0	2.0	3.0	2.67
Pelecypoda	Density	109.0	78.0	211.0	132.67	268.00	413.0	283.0	321.34		228.0	208.0	218.00	246.0	152.0	354.0	250.65
	Biomass	.620	.880	1.747	1.0824	1.384	2.929	2.045	2.1194		3.915	.985	2.4500	2.149	2.615	3.818	2.8607
	Number of species	5.0	3.0	7.0	5.00	4.0	6.0	7.0	5.67		7.0	5.0	6.0	7.0	9.0	6.0	7.33
TOTAL	Density	118.0	103.0	224.0	148.34	301.0	445.0	304.0	349.99		258.0	219.0	238.50	264.0	175.0	385.0	274.65
	Biomass	.875	1.895	2.147	1.6090	5.434	4.660	3.788	4.6274		5.425	1.133	3.279	3.764	3.016	4.777	3.8524
	Number of species	13.0	13.0	13.0	13.00	17.0	16.0	18.0	17.00		18.0	12.0	15.0	19.0	17.0	20.0	18.67

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	Scientific Name	Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Annelida																	
Polychaeta																	
Errantia																	
Glyceridae	*Glycera capitata*	2.0 (.019)	2.0 (.041)		1.33 (.0200)	2.0 (.012)	4.0 (.052)	1.0 (.143)	2.33 (.0690)	2.0 (.086)	3.0 (.068)	2.0 (.020)	2.33 (.0580)	2.0 (.250)	2.0 (.006)	4.0 (.033)	2.67 (.0963)
	Glycera tesselata									1.0 (2.259)			0.33 (.7530)				
Goniadidae	*Glycinde armigera*					1.0 (.014)		1.0 (.003)	0.67 (.0057)								
	Goniada brunnea														1.0 (.245)		0.33 (.0817)
	Glycinde picta	1.0 (.029)			0.33 (.0097)		1.0 (.002)		0.33 (.0007)		1.0 (.007)		0.33 (.0023)		2.0 (.315)		0.67 (.0150)
Lumbrineridae	*Lumbrineris bicirrata*	1.0 (.835)			0.33 (.2783)												
	Lumbrineris luti		3.0 (.030)		1.0 (.0100)	4.0 (.038)	5.0 (.032)	2.0 (.008)	3.67 (.0260)	1.0 (.003)	3.0 (.020)	2.0 (.020)	2.00 (.0143)	1.0 (.005)		2.0 (.004)	1.00 (.0030)
Nephtyidae	*Nephtys ferruginea*	1.0 (.002)			0.33 (.0007)	3.0 (.012)	10.0 (.047)	3.0 (.021)	5.33 (.0267)	1.0 (.012)		2.0 (.003)	1.00 (.0050)	2.0 (.012)	1.0 (.002)	2.0 (.067)	1.67 (.0270)
Nereidae	*Nereis procera*															1.0 (.020)	0.33 (.0067)
Onuphidae	*Onuphis iridescens*	1.0 (.022)	1.0 (.001)		0.67 (.0077)	2.0 (.024)	4.0 (.135)		2.00 (.0530)	2.0 (.152)	2.0 (.110)	1.0 (.026)	1.67 (.0960)	2.0 (.110)		1.0 (.012)	1.00 (.0407)
	Eteone sp.		1.0 (.010)		0.33 (.0033)												
Polydontidae	*Peisidice aspera*	1.0 (.004)			0.33 (.0013)												
Polynoidae	*Polynoid* sp.									1.0 (.015)	2.0 (.031)		1.00 (.0153)			1.0 (.002)	0.33 (.0007)

Replicate and Mean Density and Biomass*

Table

<u>Density and Biomass of Benthic Assemblages, Elliott Bay</u>

<u>Sampled 2,3,5 February 1976</u>

Phylum / Class / Subclass / Order / Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$	1	2	3	$\bar{x}$
Errantia																	
Sphaerodoridae	*Sphaerodoropsis sphareulifer*										1.0 (.001)		0.33 (.0003)				
Syllidae	*Syllis* sp.							1.0 (.002)	0.33 (.0007)	1.0 (.002)			0.33 (.0007)				

231

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum Class Subclass Order Family	Scientific Name	Replicate and Mean Density and Biomass*															
		Station 13				Station 14				Station 15				Station 16			
		1	2	3	x̄	1	2	3	x̄	1	2	3	x̄	1	2	3	x̄
Annelida																	
Polychaeta																	
Sedentaria																	
Ampharetidae	Ampharete goesi							1.0 (.024)	0.33 (.0080)								
Capitellidae	cf. Heteromastus filobranchus					4.0 (.033)	6.0 (.202)	3.0 (.069)	4.33 (.1013)	7.0 (.096)	1.0 (.010)	1.0 (.022)	3.00 (.0427)	9.0 (.227)	3.0 (.060)	1.0 (.003)	4.33 (.0967)
Chaetopteridae	Unknown sp.															1.0 (.025)	0.33 (.0083)
Disomidae	Unknown sp.							1.0 (.003)	0.33 (.0010)								
Maldanidae	Euclymene zonalis						2.0 (.025)	2.0 (.020)	1.33 (.0150)	2.0 (.028)	1.0 (.010)		1.00 (.0127)	2.0 (.025)			0.67 (.0083)
	Praxilella gracilis							1.0 (.058)	0.33 (.0193)	3.0 (.043)			1.00 (.0143)	2.0 (.688)		1.0 (.050)	1.00 (.2460)
Paraonidae	Aricidea quadrilobata					1.0 (.002)	2.0 (.003)		1.00 (.0017)								
Pectinariidae	Pectinaria californiensis	1.0 (.018)			0.33 (.0060)		2.0 (.106)		0.67 (.0353)					1.0 (.038)		2.0 (.060)	1.00 (.0327)
Spionidae	Laonice cirrata	3.0 (.276)	1.0 (.612)	1.0 (.060)	1.67 (.3160)		2.0 (.666)	1.0 (.305)	1.0 (.3237)			1.0 (.150)	0.33 (.0500)	1.0 (.275)			0.33 (.0917)
	Prionospio malgreni		1.0 (.016)		0.33 (.0053)												
	Spiophane sp.					1.0 (.048)			0.33 (.0160)								
Terebellidae	Unknown sp.						1.0 (.024)		0.33 (.0080)								
	Terebellides stroemi	1.0 (.023)			0.33 (.0077)												
	Trichobranchus glacilis									1.0 (.025)				0.33 (.0083)			

Table

Density and Biomass of Benthic Assemblages, Elliott Bay

Sampled 2,3,5 February 1976

Phylum / Class / Subclass / Order / Family	* Scientific Name	Station 13: 1	2	3	$\bar{x}$	Station 14: 1	2	3	$\bar{x}$	Station 15: 1	2	3	$\bar{x}$	Station 16: 1	2	3	$\bar{x}$
		Replicate and Mean Density and Biomass*															
Mollusca																	
Gastropoda																	
Prosobranchia	Barleeia sp.					2.0 (.001)		6.0 (.009)	2.67 (.0033)	2.0 (.007)	1.0 (.001)		1.00 (.0027)	5.0 (.008)	4.0 (.010)	8.0 (.006)	5.67 (.0080)
	Mitrella gouldi	1.0 (.080)			0.33 (.0267)		1.0 (.098)		0.33 (.0327)		2.0 (.066)		0.67 (.0287)	3.0 (.183)	1.0 (.080)		1.33 (.0877)
	Natica clausa									1.0 (.959)			0.33 (.3197)				
	Oenopota sp.													1.0 (.002)	1.0 (.011)		0.67 (.0043)
	Polinices sp.			1.0 (.010)	0.33 (.0033)					1.0 (.502)			0.33 (.1673)				
	Turbonilla sp.													1.0 (.002)			0.33 (.0007)